

**Subprime's long shadow:  
Understanding subprime lending's role in the St. Louis  
vacancy crisis**

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## Abstract

Using loan-level data, this analysis attempts to connect the events of the subprime home loan boom to the current vacancy crisis in St. Louis, Missouri. Borrowers in Black areas in the north of St. Louis City and St. Louis County received subprime home loans at higher frequencies during the subprime boom period of 2003-2007 than those in White areas, with differences in balloon loans especially stark. Specifically, borrowers in Black neighborhoods received subprime loans more frequently than those with equal FICO scores in White neighborhoods. As a result of these differential loan terms, North City and inner ring “First Suburb” areas saw more foreclosure and borrower payment delinquency, which in turn were highly associated with home vacancy, controlling for other risk factors. However, foreclosure was no longer a significant predictor of home vacancy after controlling for demographic factors and FICO score, indicating that the unequal loan terms may have driven much of the increase in home vacancy in the St. Louis area since the Great Recession.

*JEL classification:* R1; R3; R11; R31; J1; J15

Keywords: Subprime; St. Louis; Vacancy; Housing

## Introduction

Northern St. Louis is a remarkably empty place, with more than 40% of housing stock unoccupied in some ZIP codes. Meanwhile, majority-White South County and South City have remained relatively untouched by home vacancy. Different regions across St. Louis also saw wildly different trends during the subprime home loan boom, as majority-Black neighborhoods bore the brunt of the subprime burden. This study investigates the mechanisms of the subprime boom in St. Louis and how it may have translated into the vacancy crisis the city now faces. It does this by answering three key research questions:

- 1) Who received subprime home loans? Did it vary by the kind of subprime loan?
- 2) How much did subprime loans impact borrower payment delinquency for different St. Louis regions?
- 3) How did past foreclosures and delinquency affect today's home vacancy rates?

Borrowers in Black neighborhoods in North St. Louis with the same credit score as borrowers in White neighborhoods received subprime home loans at higher frequencies. In particular, borrowers in these Black neighborhoods received risky balloon home loans more frequently. North St. Louis neighborhoods saw more foreclosure and borrower payment delinquency, and FICO score also predicted these two measures. This delinquency caused by unequal loan terms ultimately translated into higher rates of home vacancy in Black neighborhoods.

### *Housing History of St. Louis*

St. Louis is widely known as one of the most segregated cities in the United States. More than 95% of residents north of Delmar Boulevard are Black, while almost two-thirds of those south of Delmar are White. This separation is infamously known as the “Delmar Divide” (Cooperman, 2014). St. Louis ranks tenth in the nation by White/non-White dissimilarity index, a commonly used measure of segregation (Cortright, 2020). This represents a stark improvement from 1970, when the city ranked seventh.

While the St. Louis metropolitan area is large, this analysis focuses on two counties, St. Louis City and St. Louis County, which make up the bulk of the area's population. The City of St. Louis lies on the Mississippi River and is shaped like a teardrop as shown in Figure 1. The city has remained a separate county from the bordering St. Louis County since 1877 (Levitt, 2010).

Both the private market and the government contributed to St. Louis' north-south racial divide. The city government segregated public housing and introduced racial zoning to create commercial buffer zones between White and Black neighborhoods starting in 1916 (Cooperman, 2016). Neighborhoods wrote restrictive covenants that prohibited homeowners from selling their house to any Black person. Banks refused to offer mortgages or home improvement loans to Black residents in majority-White neighborhoods (Glaeser & Vigdor, 2012).

Currently (in 2022), about 45% of St. Louis City residents are Black, compared to a much lower 25% in the County. However, because St. Louis County is so much larger than the city—it has

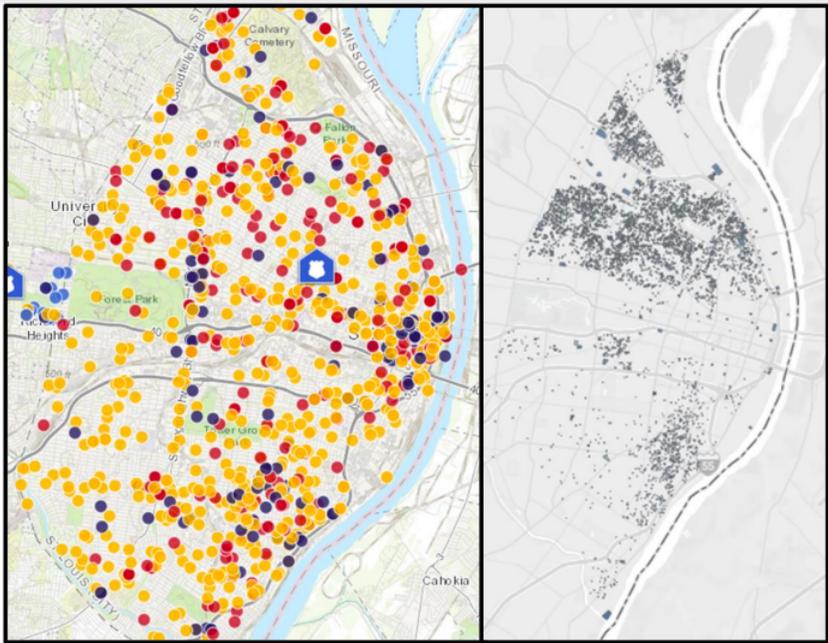
about 1 million residents compared to the city’s 300,000—the County contains 80% more Black residents than the city (QuickFacts, 2022). After anti-segregation legislation like the Fair Housing Act of 1968 passed, many Black families moved out of inner cities. In St. Louis, Black families with means moved into suburbs like Ferguson or Jennings, many left the St. Louis area altogether, and few moved into White suburbs in St. Louis County or the southern half of the city.

*Vacancy and the Great Recession*

In response to this exodus, White families moved even further away from the city, a phenomenon known as “White flight.” Many other cities with large Black populations went through this process (Glaeser & Vigdor, 2012). Despite this pattern of White flight, Glaeser and Vigdor of the Manhattan Institute found that Black suburbanization explains much of the national decline in segregation.

**Figure 1**

*Map of 2019 St. Louis City Crime (left) and Building Vacancy (right)<sup>2</sup>*



Although segregation has fallen somewhat in St. Louis City, the city’s population also has fallen and vacancy rates have skyrocketed. The number of residents has more than halved since 1970 and fallen by nearly seven percent since 2010 (Resident Population, 2022). As of 2018, St. Louis had the third-highest percentage of vacant houses of any U.S. city, with nearly six percent of the city’s housing stock left unoccupied

(Barker, 2018). Former Mayor Lyda Krewson’s office estimates that there are 25,000 vacant properties in the city, costing the city \$66 million in 2017 (Krewson, 2018). Recent research indicates that the true number of vacancies is actually between 33,000 and 50,000, of which the city owns between a quarter and a third (Prener et al., 2020).

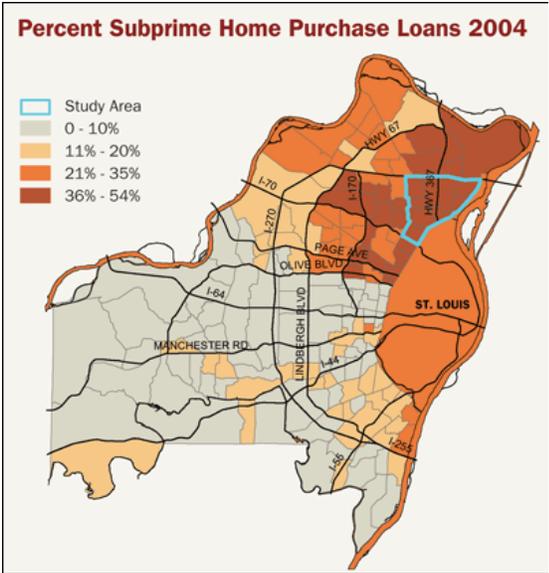
<sup>2</sup> Left plot: Yellow dots represent property damage or robbery, red dots indicate assault, dark blue dots indicate social issues like drug overdose. The blue pentagon represents a police station. Right plot: Dots are known or suspected vacant lots.

The consequences of vacancy are multiple and socially deleterious. Most importantly, vacancy rates in St. Louis City are associated with high crime. A map of building vacancy compiled by researchers at Southern Illinois University – Edwardsville, depicted in Figure 1, mirrors the map of violent crime, confirming that long-term building vacancy has a strong relationship with heightened crime in the community (Flach et al., 2019).

However, empirical studies find that vacancy not only is correlated with crime, but that it also causes increased crime. A study of properties in Pittsburgh finds that violent crime rates increase by 19% once a foreclosed home becomes vacant, and they only increase more with longer periods of vacancy (Cui & Walsh, 2015). Another study that used panel data over a 5-year period from 126 MSAs finds that home vacancy had a positive and significant effect on burglary rates within and between cities during the housing crisis (Jones & Pridemore, 2016).

Empirical work shows that this result has replicated itself in the City of St. Louis. A 2021 study illustrates that vacancy presents a strong, consistent risk for both homicide and aggravated assault and that this pattern emerges most clearly in the northern part of the city. The concentration of criminal violence in South City is driven primarily by public hubs, including housing, transportation, and schools (Fox et al., 2021). The results underscore the importance of vacancy as a driver of the spatial concentration of violent crime even within a city—certainly one as heterogeneous as St. Louis.

**Figure 2<sup>3</sup>**  
*Racial Disparities in Subprime Loans in St. Louis, 2004*



Part of St. Louis’ vacancy crisis may be due to effects from the 2008 housing market crash. The northeast part of St. Louis County felt the housing market crash most. This was because residents in this part of the county—the “First Suburbs”—had taken out subprime loans at far higher rates than in the rest of the county. In northeast St. Louis County from 2000 through 2004, the share of subprime lending for both purchase loans and refinancing rose from 28% to 42% according to a study using Home Mortgage Disclosure Act data by Michael Duncan at the Federal Reserve Bank of St. Louis. In 2005, 71% of purchase loans were high-interest loans in this area, and that figure rose to 75% the next year (Duncan, 2008). In

<sup>3</sup> Note. From “Snapshot: An Ordinary Suburb, An Extraordinary Number of Foreclosures,” by M. Duncan, Federal Reserve Bank of St. Louis, <https://www.stlouisfed.org/publications/bridges/fall-2008/snapshot-an-ordinary-suburb-an-extraordinary-number-of-foreclosures>.

particular, residents of these First Suburbs purchased homes with subprime loans much more frequently than in other areas of the County as seen in Figure 2.

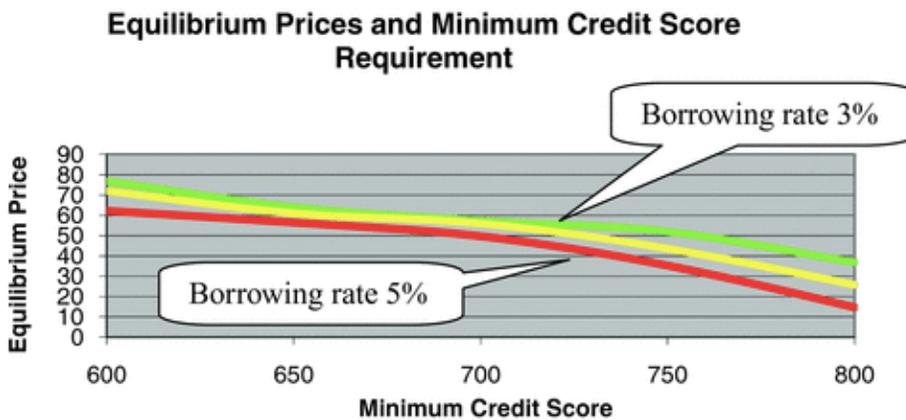
Before and after the bubble burst, Duncan’s First Suburb area, marked in blue in Figure 2, saw foreclosure rates higher than in the rest of the County. With just six percent of the housing units in the County, the area had 23% of the foreclosures at 3,007 total between 2004 and 2008. County foreclosures in this period amounted to four percent of the number of single-family homes and condos, while 14% of these properties in the northeast corner of the County were foreclosed on (Duncan, 2008). Duncan’s study of St. Louis is a useful one, but HMDA data limit analysis severely. HMDA rules require lenders to report the rate spread, but a high rate spread is often seen as not enough to classify a loan as subprime.

*Possible Explanations of the Subprime Boom’s Different Impacts Around St. Louis*

Why did these heavily Black neighborhoods suffer so much from the housing crash while South County and South City neighborhoods did not? One explanation posited by economists was that lenders relaxed their lending standards, especially in minority neighborhoods. This could have expanded lender profit by originating loans at a faster pace—but not for everyone. A 2011 study by Hubbard et al. finds that minorities were less likely to be rejected than Whites in the subprime market. That study also finds that the reduction in rejection rates to minority neighborhoods from 1996 to 2008 could not be fully justified by risk, suggesting an influx of unwarranted risky home loans minority neighborhoods (Hubbard et al., 2011). In turn, borrowers could not keep up with payments and fell into default.

**Figure 3**

*Lower Lending Standards Lead to Increased Real Estate Prices<sup>4</sup>*



Rising credit demand growth may have also contributed to relaxed lending standards in First Suburb areas. In the US as a whole, home loan denial rates were relatively lower in areas that experienced faster credit demand growth.

Lenders in these high-growth areas appear to have attached less weight to applicants’ loan-to-income

<sup>4</sup> Based on economic models from Pavlov and Wachter, reducing the minimum credit score needed to acquire a home loan increases the equilibrium price of real estate. This happens regardless of interest rate, as the 3%, 4%, and 5% cases are depicted.

Note. From “Subprime Lending and Real Estate Prices,” by A. Pavlov and S. Wachter, *Real Estate Economics* 39, no. 1 (2011), <https://doi.org/10.1111/j.15406229.2010.00284.x>.

ratios, even after controlling for supply-side factors, including house price appreciation, mortgage securitization, and other economic fundamentals (Dell'ariccia et al., 2012).

The relaxed lending standards across the US also led to more volatile housing markets in terms of price. One 2011 study finds that regions that receive a high concentration of aggressive lending instruments experience larger price increases and subsequent declines than areas with low concentration of such instruments (Pavlov & Wachter, 2011). The supply of aggressive mortgage-lending instruments such as subprime loans allows more borrowing than would otherwise occur. Asset prices temporarily increase because agents find it more attractive to own, the borrowing constraint is relaxed, or both. Figure 3 illustrates how riskier lending practices (in this case lowering the minimum credit score) can lead to higher real estate prices. This may have acted as an incentive for lenders to relax their standards.

The research noted above explains how minorities across the country were most susceptible to the housing crash of 2008, but very little research has touched on the connection between subprime loans and home vacancies. Especially in St. Louis County, where some neighborhoods saw three-quarters of their home loans classified as subprime, this complex relationship may have led to some of the multimillion-dollar problems the region faces today. The problems mean more than just money, though. If interventions in the housing market can reduce home vacancy, local leaders could gain a tool to combat a wide array of social ills, including crime, population decline, and even adverse health outcomes.

## Data

The data for this study come from both public and private sources. Public-source demographic data are used to understand who is living in the studied neighborhoods and how the composition of those neighborhoods has changed since 2000. Data from CoreLogic's Loan-Level Market Analytics (LLMA) data base help investigate the home loan market's role in vacancy in St. Louis and elsewhere. Data cleaning, parsing, and analysis were performed in R. Mapping was performed in Microsoft Excel.

### I. Publicly available data

#### *Sources and methods*

Demographic data are taken from U.S. Census Bureau records using NHGIS IPUMS. These data include racial distributions, marriage rates, unemployment rates, home ownership, median age, median structure age, median gross rent, and home vacancy by ZIP Code Tabulation Area (ZCTA) in the year 2000. Median income in the year 1999 comes from 2000 Census data and was adjusted to 2019 dollars using the Bureau of Labor Statistics' CPI Inflation Calculator. To understand how these demographics changed over time, analysis includes these same statistics from American Community Survey data for the years 2015-2019, also by ZCTA. This interval was chosen to pick up on changes since the Great Recession but avoid changes related to COVID-19.

*Descriptive Statistics*

For all that St. Louis has changed over the last several decades, much of the area is still divided along racial lines. Just under half of St. Louis City’s residents are Black, and virtually all of them live north of Delmar Blvd. in North City. While Black residents have left South City in droves—with many moving to St. Louis County—the median ZCTA in North City housed 90% Black residents in 2015-19. That figure has not changed much since the start of the new millennium. The median proportion of Black residents in every St. Louis region has increased since 2000, but the differences between the northern and southern regions are stark. In the least-Black part of North County, the median fraction of Black residents is 61.4% as of 2015-19. In South County/South City, that fraction is still just 4.5%.

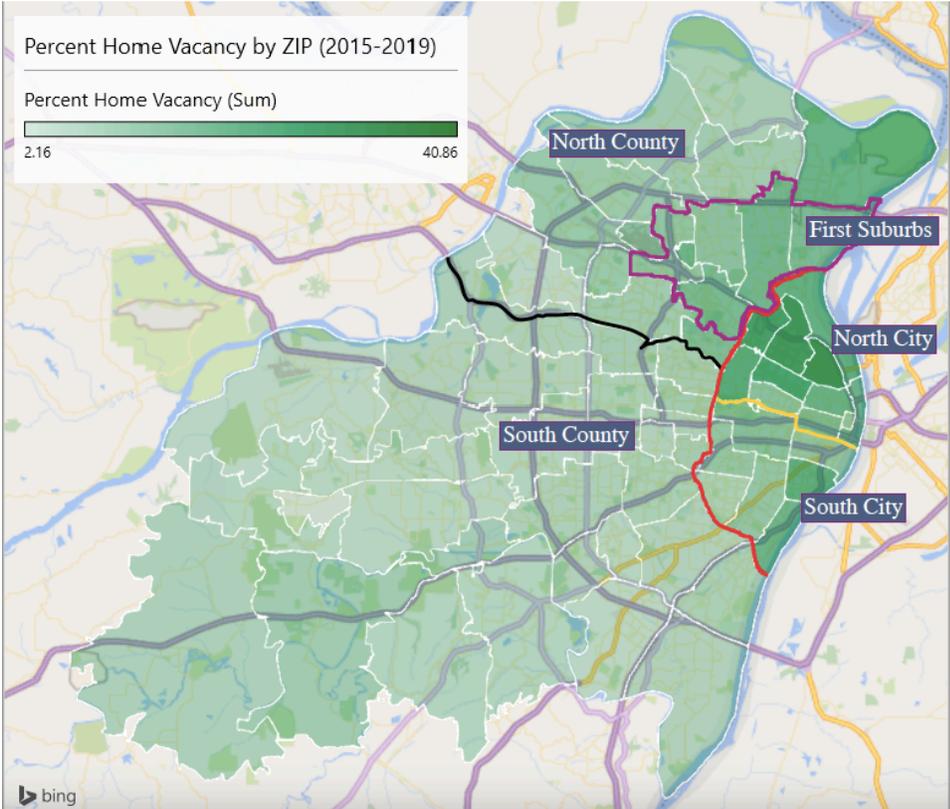
**Table 1**  
*Race by St. Louis Region Over Time*

Region	Percent Black Residents in ZCTA	
	Median (2000)	Median (2015-19)
North City	88.5%	90.4%
First Suburbs	63.4%	73.3%
North County	18.1%	61.4%
South County/South City	2.7%	4.5%

The disparity between North and South County pops up again in household income statistics. The median value for median real income in 1999 in South County/South City ZCTAs was \$81,150. It fell by 1.4% to about \$78,000 over the next two decades. However, northern St. Louis saw much larger drops in median real household income. The median value for median real household income was \$51,524 in the First Suburbs and \$57,172 in other North County ZCTAs in 1999. Since then, those values have fallen by 29% in the First Suburbs and by 19% in other North County ZCTAs. It is not clear what is causing the drop in income. It could be jobs leaving the region—the manufacturing jobs that employed many Black North County residents in the 20th century have been moved or eliminated. Alternatively, highly-skilled workers could have simply left the region to pursue a higher quality of life.

Whatever the case may be, the disparities between St. Louis regions continue in home vacancy. South County and South City remain mostly untouched by home vacancy, with between two and 10% of each ZIP code’s housing stock left vacant. Meanwhile, some northern ZIP codes have more than 40% of their housing stock unoccupied. Figure 4 maps the percent of unoccupied homes in each ZIP code in St. Louis City and St. Louis County. Home vacancy looks like the biggest problem in North City, but trouble seems to be creeping toward the First Suburbs and the rest of North County.

**Figure 4**  
*Home Vacancy by ZIP in St. Louis City and St. Louis County, Aggregated from 2015-2019*



One possible explanation for these differences in home vacancy is that poor loan terms forced homeowners into default and foreclosure and eventually out of St. Louis altogether. This exodus may have caused the current vacancy crisis in St. Louis. This mechanism would explain why home vacancy is concentrated in the North City and First

Suburb regions as shown in Figure 4. However, it is not clear whether this is true, and if so, what exactly caused the different loan terms.

**II. CoreLogic Data**

*Sources and methods*

The study also uses data from CoreLogic’s LLMA database. Specifically, characteristics of loans made in the studied areas were pulled from the Loan Origination data, which includes 55 variables on each loan recorded. Information on borrower payment delinquency was taken from CoreLogic’s Performance data set.

Missing data played a small role. About half of the values for the back-end ratio were missing, as were 10% of FICO scores at origination. A predictive mean matching method imputed values for these variables. With about four percent missing information, four imputations of 20 iterations each were used, per standard recommendation for predictive mean matching (White et al., 2011).

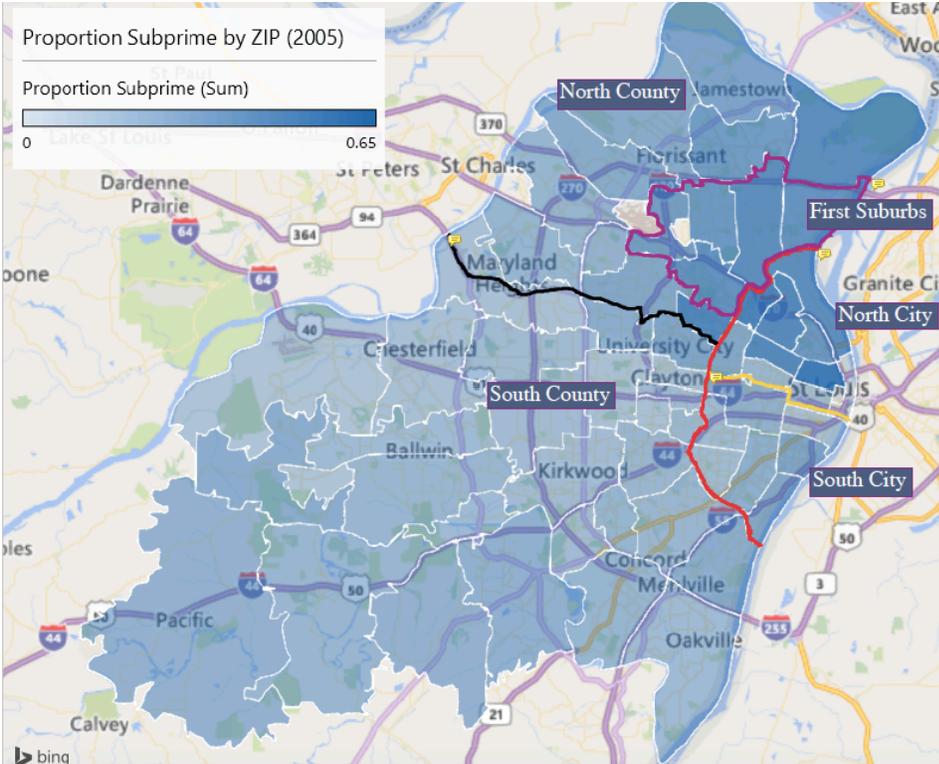
The origination data consisted of information on loan terms from 315,972 individual loans in St. Louis City and St. Louis County identified by their ZIP code. The performance data consisted of information on borrower payment delinquency from only 171,540 St. Louis City and County loans. They were identified only by loan ID, which were cross referenced with the origination data

set to find matching loans. This resulted in the smaller performance data set, as all loans in the performance data are a subset of those in the origination data. While the selection of loans is likely not random—probably due to the way CoreLogic compiles its information—the samples are very alike in almost all demographic factors measured (Appendix A). Thus, the performance data set makes up an extremely representative sample of loans from the St. Louis City and County areas.

*Descriptive Statistics*

Michael Duncan’s analysis of HMDA data found stark differences in the proportion of subprime loans between the First Suburbs and the rest of St. Louis County. Analysis of CoreLogic data corroborates this finding, with a more detailed definition of “subprime” and a slightly larger designated First Suburb region. Figure 5 shows the proportion of home loans in each ZIP code that were subprime in 2005. North City and North County and especially the First Suburb ZIP codes outlined in purple saw a much higher proportion of home loans that were subprime that year.

**Figure 5**  
*Proportion of Subprime Home Loans by ZIP Code, 2005*



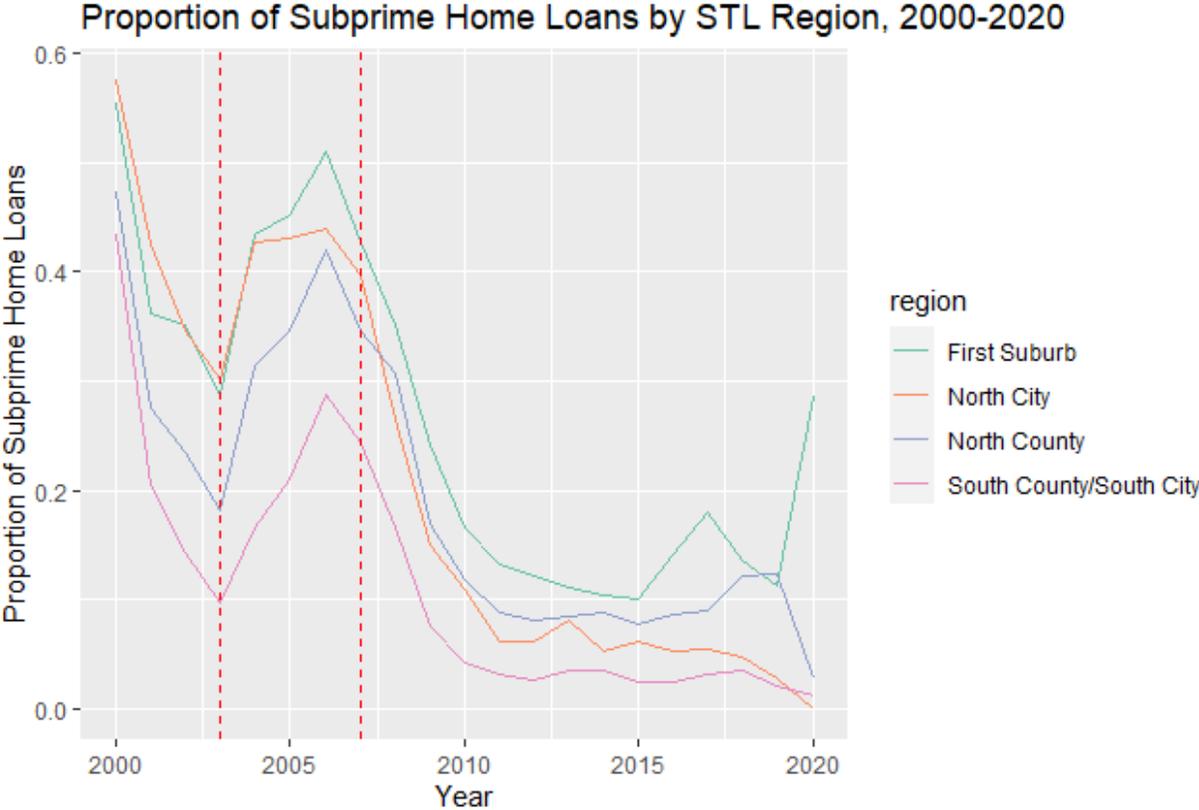
In fact, the proportion of subprime home loans in First Suburb ZIP codes in 2005 was 43.7%, the highest among all St. Louis regions. By comparison, North City and the other portions of North County saw only a proportion of subprime home loans of around 35%. The rest of the St. Louis area seems to be relatively immune to the subprime fever

during the height of the boom. The fraction of subprime home loans in the combined South County/South City regions was just 19.5% subprime.

This phenomenon holds up over nearly the whole of the subprime boom from 2003-2007 and even after the Great Recession. Neighborhoods in the First Suburb region of St. Louis received subprime loans at consistently higher rates than other parts of the St. Louis area during the boom

period marked by the red dashed lines in Figure 6. The First Suburbs originated subprime home loans at even higher rates than North St. Louis City and North County.

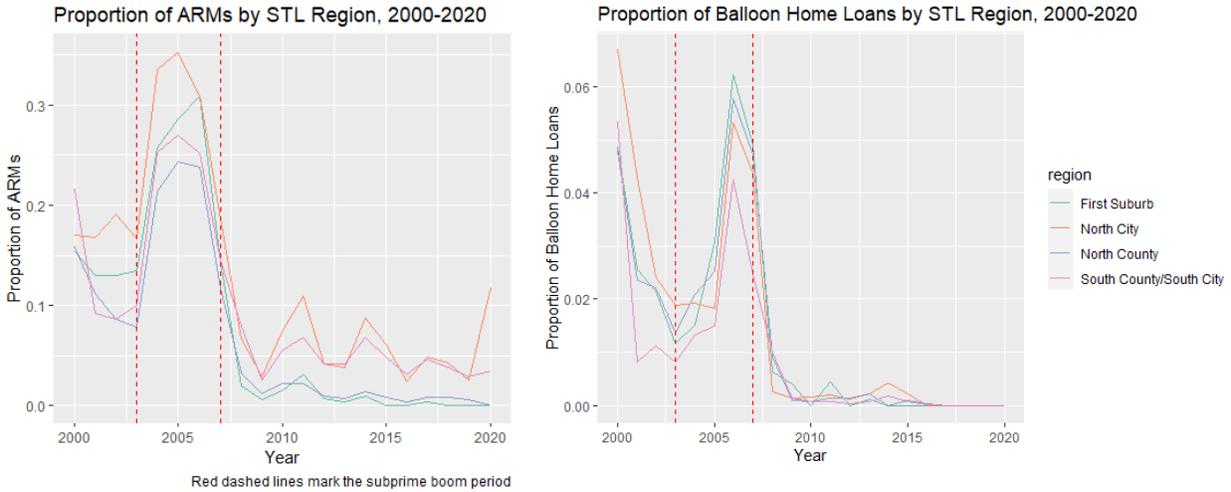
**Figure 6**  
*Proportion of Subprime Loans by Region (2000-2020)*



This trend replicated itself for balloon loans only and not adjustable-rate mortgages, otherwise known as ARMs. Balloon loans involve a large lump sum payment, typically at the end of the loan term. ARMs have a variable interest rate tied to a specific market benchmark. First Suburb ZIPs saw balloon loans more frequently than their neighbors around the St. Louis area, but there was no appreciable difference in ARMs.

In the left-hand panel of Figure 7, the differences in the frequency of ARMs between the St. Louis regions seem small during the subprime boom period of 2003-07. About 25-35% of new home loans were ARMs at their peak in all regions. However, the right-hand panel of Figure 7 shows much more apparent differences among St. Louis regions in the frequency of balloon loans. At their peak, more than six percent of all First Suburb and other North County home loans were balloon loans. This rate never rose above 4.2% for the other regions during the boom period. The difference in balloon loans is especially alarming because they have been shown to be a strong predictor of default and foreclosure.

**Figure 7**  
*Proportion of ARMs and Balloon Loans by Region (2000-2020)*



But what do the borrowers look like on a regional level? Table 2 depicts statistics on the FICO scores and back-end ratios of borrowers in each St. Louis region, with data from the 2003-2007 subprime boom period. South County/South City borrowers had much higher FICO scores than other regions. The mean FICO score for these borrowers was 57 points higher than the mean FICO score in the First Suburbs and 49 points higher than the average in North City. The south of St. Louis also has a lower average back-end ratio—also known as debt-to-income ratio—than the other regions, but not by much. The mean ratio for all regions hovers around 36%. However, this is probably due in part to self-selection, as lenders have traditionally used 36% as the maximum allowable ratio.

**Table 2**  
*Descriptive statistics of borrower characteristics by St. Louis region in subprime boom period, 2003-2007*  
 N = 315,972 home loans

Region	Mean FICO Score	Std. Dev. FICO Score	Mean Back-End Ratio	Std. Dev. Back-End Ratio
North City	647.2	85.0	36.0	15.2
First Suburbs	639.6	81.6	36.2	15.3
North County	665.1	84.0	36.3	15.5
South County/South City	696.7	77.1	35.4	16.3

Even though borrowers in South County/South City were generally more creditworthy, ARMs were relatively common in all regions during the boom period, as shown in Figure 7. Nearly 23% of all North City home loans in the boom period were ARMs, but 17.4% of loans were ARMs in the South County/South City region. However, these mortgages were not built the same. Black

borrowers saw much higher margins on their ARMs. The average margin during the boom was five percent in the First Suburbs and in North City but just 3.1% in the White South County/South City region. The ARM margin is the amount that the borrower must pay above the index rate. So, a higher margin means a borrower must pay more. This may explain some of the high ARM frequencies in the southern areas of St. Louis.

The loan-to-value ratio exhibits great differences between the South County/South City and First Suburb areas. In fact, the mean LTV in the south of St. Louis is 13% smaller than in First Suburb home loans. This may account for why South County/South City loans were risky compared to First Suburb loans using common metrics like the proportion of ARMs shown above but did not result in the same kind of foreclosure. In terms of LTV, home loans in St. Louis’ south were extremely low-risk, while First Suburb loans were considered much higher-risk.

There are some differences in documentation rates between the studied areas in North and South St. Louis during the boom period. Nearly 6% of North City home loans lacked any asset or income verification, while only 2.7% of South County/South City loans lacked documentation. However, North County had an even lower share of loans without asset or income verification at just 2.3% missing.

**Table 3**  
*Descriptive statistics of home loans by St. Louis region*

Region	Percentage of Subprime Home Loans During Boom Period	Percentage of Foreclosed Home Loans as of 2020	Percentage with 60-Day Payment Delinquency
North City	40.6%	0.6%	1.6%
First Suburbs	42.8%	1.0%	2.1%
North County	31.7%	0.6%	1.4%
South County/South City	18.7%	0.2%	0.4%

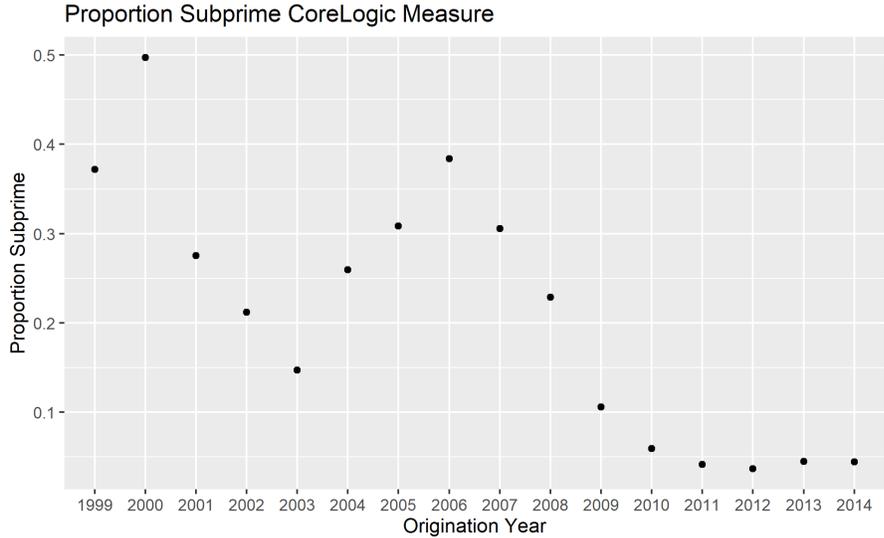
First Suburb home loans were classified as subprime at extremely high rates during the 2003-2007 boom period. Table 3 shows that nearly 43% of loans in this region were subprime during this period, compared to below 20% in South County/South City. About 56% of all home loans in the First Suburb ZIP code 63133 during the boom period were subprime. This area includes troubled Bel-Nor, the neighborhood which “The Exorcist” was based on. By comparison, 38.7% of home loans in Ferguson were classified as subprime during the boom period, which is less than the overall regional average but still more than double the South County/South City average.

These figures are certainly eye-popping. In the true national subprime boom from 2004-2006, around 20% of home loans were subprime. For the North City and First Suburbs to have figures double that for the entire first decade of the 2000s is simply astounding. It is, however, consistent with Duncan’s analysis.

These areas also saw greater rates of foreclosure and borrower payment delinquency. As of January 2020, 1.0% of First Suburb home loans originated after 1999 were in foreclosure and 2.1% were in 60-day payment delinquency. These figures are the greatest of any region, eclipsing even

those of the more heavily Black North City neighborhoods as shown in Table 3. The White South County/South City region saw much lower rates of foreclosure and delinquency. There is a shocking 80% less foreclosure and payment delinquency in this region than in the First Suburbs.

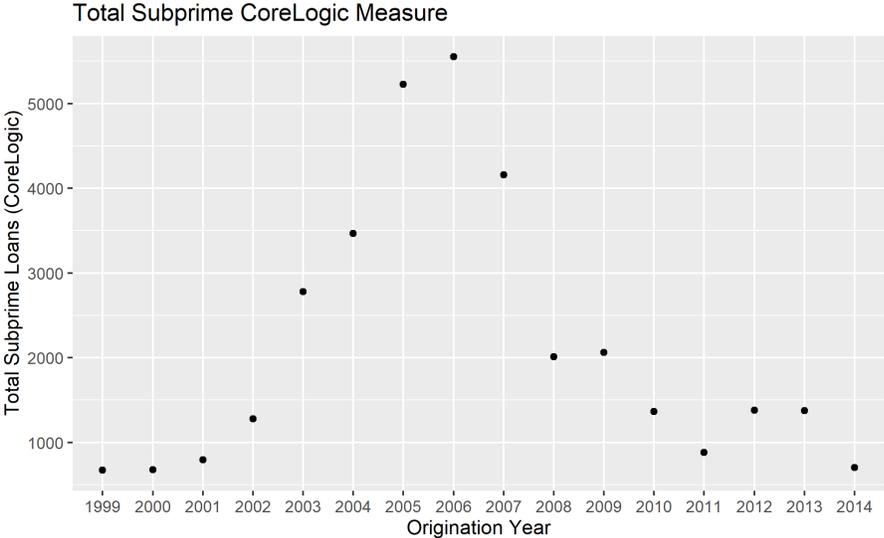
**Figure 8**  
*Proportion of St. Louis Home Loans That Were Subprime, 1999-2014*



To understand how the number of subprime home loans varied over time, Figure 8 displays the proportion of home loans that were subprime in any given year. There looks to be a peak in the years 2003-07, but the proportion appears even higher in the preceding years, especially in 2000. However, this figure is deceiving because far

fewer home loans were made in this leadup period compared to the subprime boom. This is illustrated by Figure 9, which plots the total number of subprime home loans for each year. The boom period in St. Louis is immediately obvious from this graph, and it appears to be from 2003-2007. While the proportion of home loans that were subprime fell from 2000 to 2006, the overall number of subprime loans increased by 10 times.

**Figure 9**  
*Total St. Louis Subprime Home Loans, 1999-2014*



The proportion of subprime home loans was highly correlated with a few key demographic variables. Unemployment rate was the strongest individual predictor of subprime loan proportion in any St. Louis census tract, with an astonishingly high correlation coefficient of

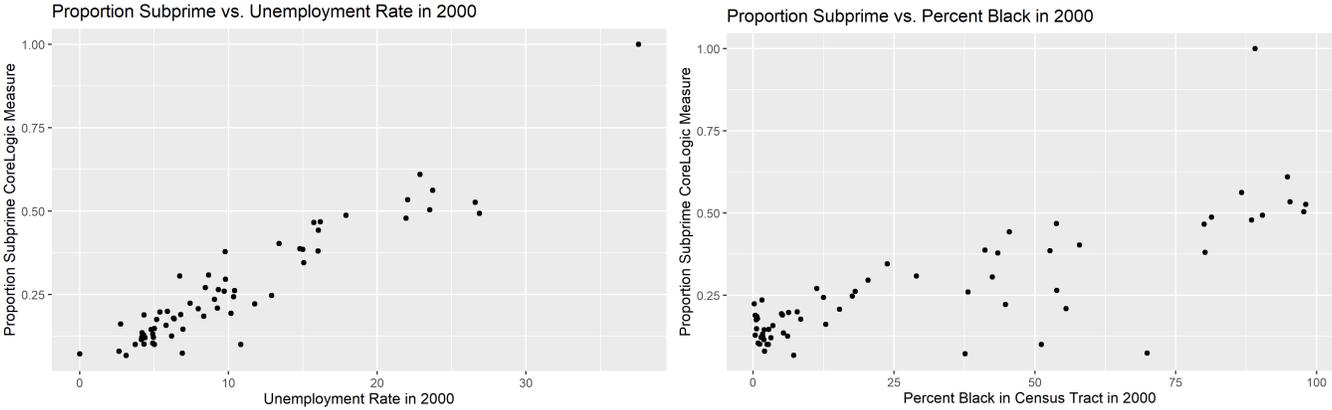
0.942. The percentage of Black residents in the census tract was the next strongest predictor with  $r = 0.799$ , followed by median age of the neighborhood at  $r = -0.667$  (Table 4).

**Table 4**  
*Correlated factors with subprime home loan proportion*

Variable	Correlation coefficient
Unemployment rate	0.942
Percent Black residents	0.799
Median age	-0.667
Median gross rent	-0.628
Median income in 1999	-0.598
Percent married	-0.559
Average household size	0.395
Median house age	0.296
Percent home ownership	-0.230

The relationship between unemployment rate and the proportion of subprime loans was linear, as shown in Figure 10. In general, the higher the unemployment rate, the higher the proportion of home loans in that ZCTA were subprime. The same trend emerged for the percentage of Black residents in a ZCTA. The younger the area was, the higher the proportion of subprime home loans. This may be explained by a young person flipping a home and not intending to stay there for an extended period (and pay the high rates that come with subprime loans).

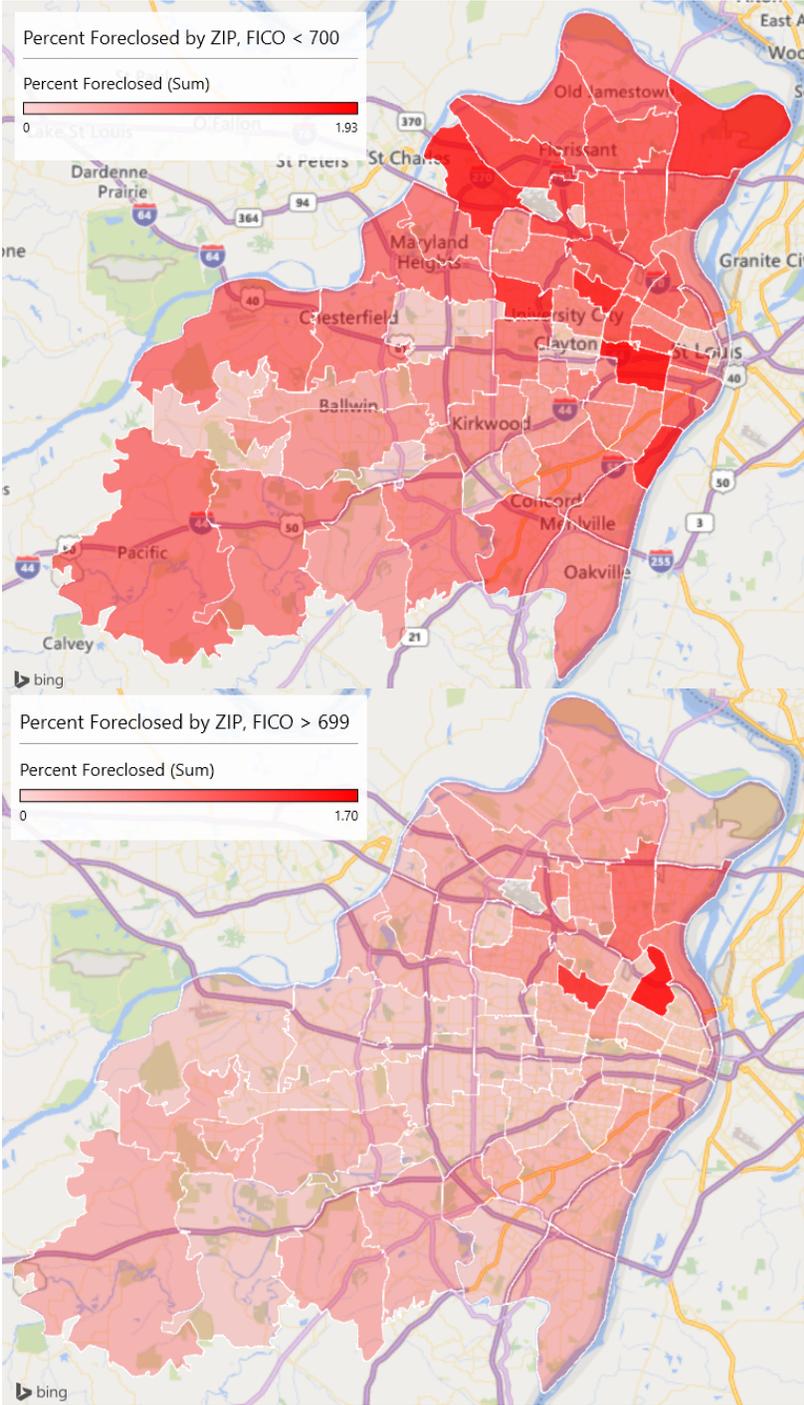
**Figure 10**  
*Strong Demographic Predictors of Subprime Home Loans in St. Louis*



The relationship between unemployment rate and subprime home loans may be that lenders were not willing to offer prime, fixed-rate mortgages to borrowers without a job. This relationship appears very strong. Of course, race and unemployment are strongly related themselves, as many companies are reluctant to place an office in North St. Louis, where crime rates are higher.

It is also important to see how borrower payment delinquency varies across St. Louis. While the CoreLogic data set does not show default since each lender has its own definition, the data set does provide measures on foreclosure. It also provides an indicator for 60- and 90-day payment delinquency, which are two common cutoffs for lenders to mark default.

**Figure 11**  
*Foreclosure by ZIP for Borrowers with Low and High FICO Scores and Loans Originated After 1999*



Along with higher rates of subprime home loans, North City and North County also saw more foreclosure. Figure 11 depicts the percent of properties in each ZIP code with a home loan originated in 2000 or later that were foreclosed on as of January 2020. In both panels of Figure 11, North City, North County (and especially First Suburb) areas are shaded with darker red, indicating more foreclosure. This means that regardless of FICO score, properties in northern parts of St. Louis were more likely to be foreclosed on.

This exploratory data analysis raises some important questions. Clearly, St. Louis’ First Suburbs and North City received subprime home loans at higher frequencies than other parts of the St. Louis. However, it is not clear exactly why this happened. It is also unclear if the differences in subprime lending by region led to higher default and foreclosure rates for First Suburb areas. And finally, the impact of subprime lending in First Suburb neighborhoods and eventual defaults on the current vacancy

crisis must be uncovered. The following section builds several logistic and linear regression models to attempt to find the answers to each of these questions.

## Framework and Empirical Specification

This analysis operationalizes the goals of the study into three questions mentioned in the introduction. They are:

- 1) Who received subprime home loans? Did it vary by the kind of subprime loan?
- 2) How much did subprime loans impact borrower payment delinquency for different St. Louis regions?
- 3) How did past foreclosures and delinquency affect today's home vacancy rates?

### *Specification for Question 1 (Subprime Origination)*

This analysis uses a logit model to see which demographic factors have the most impact on the likelihood of receiving a subprime loan. The demographic factors include a battery of variables from the American Community Survey. These factors are ZCTA-level data from the 2000 Census, like the percentage of Black residents in the ZCTA and the median age of the ZCTA. Variables like these were chosen to make up for a lack of demographic data on home buyers in the CoreLogic data set. The only two individual socioeconomic demographic variables in the CoreLogic LLMA data set are the buyer's FICO score at origination and the back-end ratio.

ZCTA-level demographic data do not paint a completely accurate picture of each individual home loan. However, as mentioned previously, St. Louis is still a relatively segregated city. The demographic description of each home loan recipient is likely to be extremely correlated with the demographic makeup of the ZCTA she lives in. This painting with a broad brush is also minimized by the size of the data set and by looking at individual-level data. The CoreLogic LLMA origination data set includes data on more than 300,000 home loans in St. Louis City and St. Louis County from 2000-2020.

The selected battery of demographic factors is taken from a study on urban elasticity (Newman et al., 2016). The ZCTA-level demographic variables include a variety of factors that are associated with urban vacancy, including unemployment and an area's racial composition. An additional *period* variable is included to account for time. The boom period is between 2003 and 2007, and the other two periods are pre-boom and post-boom.

The logit models for subprime status are composed of the following elements:

$$(I) \text{Logit}(\text{subprime}) = \beta_0 + \beta_1 (\text{fico\_score\_at\_origination}) + \beta_2 (\text{back\_end\_ratio}) + \beta_3 (\text{pct\_Black}) + \beta_4 (\text{unemployment\_rate}) + \beta_5 (\text{median\_age}) + \beta_6 (\text{pct\_home\_ownership}) + \beta_7 (\text{avg\_household\_size}) + \beta_8 (\text{median\_gross\_rent}) + \beta_9 (\text{median\_structure\_age}) + \beta_{10} (\text{median\_income\_1999}) + \beta_{11} (\text{pct\_married}) + \beta_{12} (\text{region}) + \beta_{13} (\text{period}) + \beta_{14} (\text{period} * \text{unemployment\_rate}) + \beta_{15} (\text{period} * \text{pct\_home\_ownership}) + \beta_{16} (\text{period} * \text{pct\_Black}) + \beta_{17} (\text{period} * \text{pct\_married}) + \beta_{18} (\text{period} * \text{median\_income\_1999}) + \beta_{19} (\text{period} * \text{fico\_score\_at\_origination}) + \beta_{20} (\text{region} * \text{pct\_Black}) + \beta_{21} (\text{region} * \text{period}) + \beta_{22} (\text{region} * \text{fico\_score\_at\_origination}) + \beta_{23} (\text{pct\_Black} * \text{fico\_score\_at\_origination}) + \beta_{24} (\text{region} * \text{unemployment\_rate}) + \varepsilon$$

The *region* variable is a vector of categorical variables where a loan is separated into either First Suburb, other North County, North City, or South County/South City regions. The North County region matched areas represented by North County Incorporated, a regional development association.<sup>5</sup> The *period* variable is also a vector, and any interaction terms involving *region* or *period* will produce a vector of coefficients. Several models are built using different combinations of the above features. A similar procedure follows to explore the key predictors of each main type of subprime home loan. The logit models for the types of subprime home loans, balloon loans (II) and ARMs (III), are given with the same specification as the models for subprime status. Again, the features in these models vary to understand the data from different perspectives and control for different variables. This same general procedure is followed for Questions 2 and 3.

*Specification for Question 2 (Borrower Payment Delinquency and Foreclosure)*

As in Question 1, this course of inquiry examines the effects of a battery of demographic factors on the outcome. However, Question 2 focuses on the likelihood of a home loan foreclosure or other delinquency. The specification for the dependent variables in Question 2 has many of the same features as in Question 1 but with additional indicator variables for whether a loan is subprime, and, yes, which kind of subprime (balloon loan or ARM).

The CoreLogic database lacks any measure of “default” since lenders do not share a common definition. However, it contains important data on home loan delinquency status as measured by Mortgage Bankers Association standards. The dependent variables that this portion of analysis will investigate are foreclosure (IV), 60-day delinquency (V), and 90-day delinquency (VI). The features of these models are all the same. The exact specification for modeling these three variables is similar to that of Question 1 and is as follows:

$$\begin{aligned}
 \text{(IV) Logit (foreclosure)} = & \beta_0 + \beta_1 (\text{fico\_score\_at\_origination}) + \beta_2 (\text{back\_end\_ratio}) + \beta_3 (\text{pct\_Black}) + \\
 & \beta_4 (\text{unemployment\_rate}) + \beta_5 (\text{median\_age}) + \beta_6 (\text{pct\_home\_ownership}) + \beta_7 (\text{avg\_household\_size}) + \beta_8 \\
 & (\text{median\_gross\_rent}) + \beta_9 (\text{median\_structure\_age}) + \beta_{10} (\text{median\_income\_1999}) + \beta_{11} (\text{pct\_married}) + \beta_{12} \\
 & (\text{subprime}) + \beta_{13} (\text{region}) + \beta_{14} (\text{period}) + \beta_{15} (\text{period} * \text{unemployment\_rate}) + \beta_{16} (\text{period} * \\
 & \text{pct\_home\_ownership}) + \beta_{17} (\text{period} * \text{pct\_Black}) + \beta_{18} (\text{period} * \text{pct\_married}) + \beta_{19} (\text{period} * \\
 & \text{median\_income\_1999}) + \beta_{20} (\text{period} * \text{fico\_score\_at\_origination}) + \beta_{21} (\text{region} * \text{pct\_Black}) + \beta_{22} \\
 & (\text{region} * \text{period}) + \beta_{23} (\text{region} * \text{fico\_score\_at\_origination}) + \beta_{24} (\text{pct\_Black} * \text{fico\_score\_at\_origination}) \\
 & + \beta_{25} (\text{region} * \text{unemployment\_rate}) + \beta_{26} (\text{region} * \text{pct\_home\_ownership}) + \beta_{27} (\text{-ARM}) + \beta_{28} (\text{balloon}) \\
 & + \varepsilon
 \end{aligned}$$

*Specification for Question 3 (Home Vacancy)*

The final set of models aim at discovering how foreclosure and other borrower payment delinquency may affect the final dependent variable, home vacancy (VII). The dependent variable is specifically the percentage of homes in each ZCTA that is vacant as of 2015-19, the most recent time period before the COVID-19 pandemic. Therefore, this analysis uses multivariate linear regression rather than logistic regression. These models control for the same set of demographic

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<sup>5</sup> “About NCI,” North County Incorporated, <https://northstlouiscounty.com/about-nci/>.

variables as the previous questions but includes variables for the percent of loans foreclosed on, percent of loans with 60-day delinquency, and the percent of loans with 90-day delinquency. Rather than the FICO score and back-end ratio of each individual borrower, this set of regressions uses the mean FICO score and back-end ratio for each ZCTA. The full specification is below, though some terms were not included in the final models shown in Table 10 because they never proved to be a significant predictor:

$$\begin{aligned}
 \text{(VII) } \textit{Percent\_Vacant} = & \beta_0 + \beta_1 (\textit{mean\_fico\_score}) + \beta_2 (\textit{mean\_back\_end\_ratio}) + \beta_3 (\textit{pct\_Black}) + \beta_4 \\
 & (\textit{unemployment\_rate}) + \beta_5 (\textit{median\_age}) + \beta_6 (\textit{pct\_home\_ownership}) + \beta_7 (\textit{avg\_household\_size}) + \beta_8 \\
 & (\textit{median\_gross\_rent}) + \beta_9 (\textit{median\_structure\_age}) + \beta_{10} (\textit{median\_income\_1999}) + \beta_{11} (\textit{pct\_married}) + \beta_{12} \\
 & (\textit{pct\_foreclosed}) + \beta_{13} (\textit{pct\_sixty\_day\_delinquent}) + \beta_{14} (\textit{pct\_ninety\_day\_delinquent}) + \beta_{15} (\textit{region}) + \beta_{16} \\
 & (\textit{period}) + \beta_{17} (\textit{period} * \textit{unemployment\_rate}) + \beta_{18} (\textit{period} * \textit{pct\_home\_ownership}) + \beta_{19} (\textit{period} * \\
 & \textit{pct\_Black}) + \beta_{20} (\textit{period} * \textit{pct\_married}) + \beta_{21} (\textit{period} * \textit{median\_income\_1999}) + \beta_{22} (\textit{period} * \\
 & \textit{mean\_fico\_score}) + \beta_{23} (\textit{region} * \textit{pct\_Black}) + \beta_{24} (\textit{region} * \textit{period}) + \beta_{25} (\textit{region} * \\
 & \textit{fico\_score\_at\_origination}) + \beta_{26} (\textit{pct\_Black} * \textit{fico\_score\_at\_origination}) + \beta_{27} (\textit{region} * \\
 & \textit{unemployment\_rate}) + \beta_{28} (\textit{region} * \textit{pct\_home\_ownership}) + \beta_{29} (\textit{pct\_foreclosed} * \textit{region}) + \beta_{30} \\
 & (\textit{mean\_fico\_score} * \textit{region}) + \varepsilon
 \end{aligned}$$

## Results

### *Results for Question 1 (Subprime Origination)*

Question 1 concerns who received subprime loans in the St. Louis area and which kinds of loans they received. Logit models for three dependent variables were built, one for whether a loan is subprime, another for if a loan was a balloon loan, and the last for if a loan was an ARM. All three of these point to the overwhelming influence of FICO score in the loan terms and the inequality of its treatment for different borrowers across St. Louis. Black borrowers were less able to reduce the chances of a subprime loan and a balloon loan in particular by increasing their FICO score. However, the region and race of the borrower seemed to play a much less important role in determining how lenders treated FICO score in regard to offering ARMs.

Table 5 depicts the results of the logit models for whether a particular home loan is subprime. Model (1) is the main effects model, Model (2) includes some interaction terms, Model (3) is the model with more interaction terms, and Model (4) exchanges the interaction term between FICO score and region for the interaction between FICO score and the percentage of Black residents in the ZCTA. Model (1) shows how the region of St. Louis is associated with subprime status. Both the First Suburb and North County regions are associated with subprime home loans. The odds of a subprime home loan are 17% higher for First Suburb and 24% higher for other North County loans than for South County/South City loans with all other variables held constant in this model.

FICO score plays a dominant part in determining whether a borrower receives a subprime loan. In all four models, the borrower's FICO score at origination is significant with a p-value below 0.01. As the only variable with this level of significance across all four models, FICO score plays a pervasive role in the decision to originate a subprime loan. The effect of raising a borrower's FICO

score by one point ranges across the models, but it lowers the odds of a subprime loan by between 3.7% and 4.5% with all other variables held constant.

However, Model (3) illustrates that borrowers' FICO scores were not treated the same across regions. A one-point increase in FICO score lowers the odds of receiving a subprime loan by 3.7% for loans originated in South County ZCTAs with other variables held constant. For loans originated in First Suburb areas, the same one-point increase only lowers the odds of a subprime loan by 2.8%. The difference in treatment was even more striking in North City, as the odds of a subprime loan falls by only 2.4% with a one-point increase in FICO score.

Model (4) demonstrates that the same difference in treatment of FICO score relates to race. This model includes an interaction between FICO score and the percentage of Black residents than between FICO score and St. Louis region. A St. Louis ZCTA with no Black residents sees a four percent dip in the odds of a subprime loan for every one-point increase in FICO score holding other variables constant. However, for every additional percentage point of Black residents, the dip in the odds of a subprime loan becomes smaller. In other words, the more Black the area, the less lenders consider a higher credit score in relation to originating a subprime loan. Model (4) would predict that for a ZCTA with 80% Black residents, a one-point increase in FICO score decreases the odds of a subprime loan by 2.4% compared to a 4.0% decrease for a ZCTA with no Black residents.

Table 6 drills down into the type of subprime loan, where the same patterns emerge only for balloon loans but not for ARMs. The factors most associated with balloon loans are FICO score, back-end ratio, and region. Once again, the interaction between region and FICO score stands out. In Model (2) on Table 6, a one-point increase in FICO score decreases the odds of a balloon loan by 1.05% in South County but by only 0.89% in First Suburbs, by 0.85% in other North County ZCTAs, and by just 0.68% in North City ZCTAs. Thus, Black borrowers could not change the terms of their loans as easily as White borrowers by raising their FICO score.

**Table 5***Results from the logit model (1) for the impact of demographic factors on subprime home loan status*

	<i>Dependent variable:</i>			
	subprime			
	(1)	(2)	(3)	(4)
Constant	27.2224*** (0.3377)	29.4448*** (0.3286)	24.4513*** (0.7157)	26.0819*** (0.7238)
fico_score_at_origination	-0.0457*** (0.0003)	-0.0457*** (0.0003)	-0.0381*** (0.0008)	-0.0406*** (0.0008)
back_end_ratio	0.0016*** (0.0006)	0.0016*** (0.0006)	0.0011* (0.0006)	0.0011* (0.0006)
regionFirst Suburb	0.1633*** (0.0522)	0.0921** (0.0436)	-5.7497*** (0.5551)	0.2898 (0.3336)
regionNorth City	0.0666 (0.0607)	0.0271 (0.0570)	-8.3705*** (0.5592)	0.0911 (0.2770)
regionNorth County	0.2165*** (0.0286)	0.1792*** (0.0247)	-2.3742*** (0.4056)	0.0310 (0.1315)
periodBoom	0.4784*** (0.0421)	-0.8488*** (0.2743)	0.6002 (0.6945)	0.3234 (0.6967)
periodPost-boom	0.5119*** (0.0426)	-1.1789*** (0.2731)	17.5733*** (0.7652)	16.8228*** (0.7699)
pct_black	-0.0008 (0.0009)	-0.0007 (0.0007)	0.0013 (0.0031)	-0.1073*** (0.0056)
unemployment_rate	-0.0023 (0.0052)	-0.0360*** (0.0081)	-0.0151 (0.0164)	-0.0132 (0.0162)
median_age	0.0055 (0.0051)	-0.0044 (0.0036)	-0.0037 (0.0041)	-0.0033 (0.0041)
pct_home_ownership	-0.0066*** (0.0018)	-0.0155*** (0.0031)	-0.0021 (0.0066)	-0.0010 (0.0066)
avg_household_size	0.2889*** (0.0977)			
median_gross_rent	-0.0001 (0.0001)			
median_structure_age	0.0016 (0.0014)			

median_income_1999	-0.0028** (0.0011)	0.0042 (0.0043)	0.0054 (0.0043)
pct_married	0.5767 (0.4527)	-2.1121 (1.6464)	-2.5359 (1.6337)
periodBoom:unemployment_rate	0.0420*** (0.0079)	0.0320* (0.0168)	0.0307* (0.0165)
periodPost-boom:unemployment_rate	0.0556*** (0.0081)	0.0162 (0.0173)	0.0156 (0.0171)
periodBoom:pct_home_ownership	0.0119*** (0.0032)	0.0033 (0.0070)	0.0019 (0.0069)
periodPost-boom:pct_home_ownership	0.0153*** (0.0032)	-0.0043 (0.0070)	-0.0056 (0.0070)
periodBoom:pct_black		0.0019 (0.0030)	0.0003 (0.0030)
periodPost-boom:pct_black		-0.0005 (0.0031)	-0.0043 (0.0031)
periodBoom:pct_married		1.8647 (1.7345)	2.2377 (1.7214)
periodPost-boom:pct_married		3.2260* (1.7356)	3.6165** (1.7233)
periodBoom:median_income_1999		-0.0036 (0.0045)	-0.0045 (0.0046)
periodPost-boom:median_income_1999		-0.0062 (0.0045)	-0.0072 (0.0046)
fico_score_at_origination:periodBoom		-0.0026*** (0.0008)	-0.0022*** (0.0008)
fico_score_at_origination:periodPost-boom		-0.0286*** (0.0009)	-0.0275*** (0.0009)
regionFirst Suburb:pct_black		-0.0023 (0.0024)	-0.0004 (0.0024)
regionNorth City:pct_black		-0.0033 (0.0042)	-0.0041 (0.0043)
regionNorth County:pct_black		-0.0006 (0.0021)	0.0003 (0.0021)
regionFirst Suburb:periodBoom		-0.0272 (0.1597)	0.1070 (0.1607)

regionNorth City:periodBoom	-0.2327 (0.1898)	-0.0648 (0.1887)
regionNorth County:periodBoom	0.0897 (0.1103)	0.1304 (0.1123)
regionFirst Suburb:periodPost-boom	0.0902 (0.1689)	0.3543** (0.1691)
regionNorth City:periodPost-boom	-0.2458 (0.2006)	0.0921 (0.1991)
regionNorth County:periodPost-boom	0.2441** (0.1114)	0.3323*** (0.1129)
fico_score_at_origination:regionFirst Suburb	0.0098*** (0.0007)	
fico_score_at_origination:regionNorth City	0.0134*** (0.0008)	
fico_score_at_origination:regionNorth County	0.0039*** (0.0006)	
fico_score_at_origination:pct_black		0.0002*** (0.00001)
regionFirst Suburb:unemployment_rate	-0.0257 (0.0247)	-0.0281 (0.0251)
regionNorth City:unemployment_rate	0.0079 (0.0134)	0.0080 (0.0134)
regionNorth County:unemployment_rate	-0.0172 (0.0115)	-0.0142 (0.0112)

Observations	315,972	315,972	315,972	315,972
Log Likelihood	-41,951.2300	-41,933.6800	-40,367.1800	-40,302.7100
Akaike Inf. Crit.	83,936.4700	83,899.3600	80,816.3700	80,683.4100

Note:

\*p<0.1; \*\*p<0.05; \*\*\*p<0.01

For illustration, imagine three ZCTAs: one in South County, another in a First Suburb, and the last in North City. They are identical in every demographic measured in this study—they have the same percentage of Black residents, the same unemployment rate, the same median income, and much more in common. Hypothetically, a borrower with a 600 FICO score could have a 50% chance (odds of 1) of receiving a balloon loan in any region. An identical borrower to the previous one but with a 700 FICO score would have a 25.9% chance of a balloon loan in South County compared to a 29.5% chance of a balloon loan in a First Suburb and a 34% chance in North City.

**Table 6***Results from logit models (II and III) of demographic factors' impacts on balloon loans (1, 2) and ARMs (3, 4, 5)*

	<i>Dependent variable:</i>				
	balloon		(3)	arm	
	(1)	(2)		(4)	(5)
Constant	0.8212 (0.7668)	2.1356 (1.3279)	0.4364*** (0.0748)	-0.4833*** (0.1210)	2.5180*** (0.5307)
fico_score_at_origination	-0.0108*** (0.0003)	-0.0105*** (0.0008)	-0.0032*** (0.0001)	-0.0036*** (0.0001)	-0.0068*** (0.0004)
back_end_ratio	0.0043*** (0.0013)	0.0040*** (0.0013)	-0.0073*** (0.0005)	-0.0072*** (0.0005)	-0.0048*** (0.0005)
regionFirst Suburb	0.1664 (0.1177)	-0.7500 (0.9206)	-0.1877*** (0.0261)	-0.1307*** (0.0359)	0.8179** (0.4117)
regionNorth City	0.2635** (0.1329)	-1.4541* (0.8654)	0.1961*** (0.0271)	0.2389*** (0.0432)	1.0427*** (0.3483)
regionNorth County	0.2209*** (0.0715)	-0.4653 (0.4573)	-0.5025*** (0.0192)	-0.5418*** (0.0222)	0.1877 (0.2120)
periodBoom	0.2608*** (0.0738)	-0.4307 (1.0675)	0.7202*** (0.0331)	0.7115*** (0.0333)	-0.7870 (0.4851)
periodPost-boom	-2.1245*** (0.1006)	2.0862 (1.3620)	-0.9308*** (0.0344)	-0.9857*** (0.0346)	-8.3223*** (0.5164)
pct_black	0.0056*** (0.0019)	0.0037 (0.0065)		0.0167*** (0.0006)	0.0073** (0.0028)
unemployment_rate	-0.0070 (0.0118)	0.0280 (0.0356)		-0.0830*** (0.0030)	0.0061 (0.0153)
median_age	0.0010 (0.0122)	0.0020 (0.0138)		0.0358*** (0.0023)	-0.0198*** (0.0037)
pct_home_ownership	-0.0086* (0.0046)	-0.0076 (0.0138)		0.0032*** (0.0006)	0.0091 (0.0062)
avg_household_size	0.1097 (0.2291)	-0.1045 (0.2733)			-0.6590*** (0.0890)
median_gross_rent	0.0003 (0.0003)	0.0005 (0.0003)			0.0007*** (0.0001)
median_structure_age	0.0060* (0.0034)	0.0003 (0.0042)			0.0136*** (0.0011)
median_income_1999	-0.0021 (0.0026)	0.0057 (0.0088)			0.0105*** (0.0034)
pct_married	3.4932*** (1.1101)	-0.1798 (3.4435)			-0.6922 (1.4228)
periodBoom:unemployment_rate		-0.0247 (0.0330)			0.0220 (0.0150)

periodPost-boom:unemployment_rate	0.0336 (0.0461)	-0.0656*** (0.0161)
periodBoom:pct_home_ownership	0.0073 (0.0140)	-0.0089 (0.0063)
periodPost-boom:pct_home_ownership	-0.0077 (0.0179)	-0.0159** (0.0064)
periodBoom:pct_black	0.0090 (0.0060)	-0.0011 (0.0028)
periodPost-boom:pct_black	-0.0003 (0.0084)	0.0083*** (0.0030)
periodBoom:pct_married	3.3953 (3.5395)	1.4145 (1.4578)
periodPost-boom:pct_married	1.6848 (4.2336)	1.9546 (1.4595)
periodBoom:median_income_1999	-0.0104 (0.0090)	0.0026 (0.0034)
periodPost-boom:median_income_1999	0.0049 (0.0099)	0.0079** (0.0034)
fico_score_at_origination:periodBoom	-0.0011 (0.0008)	0.0017*** (0.0004)
fico_score_at_origination:periodPost-boom	-0.0076*** (0.0011)	0.0099*** (0.0005)
regionFirst Suburb:pct_black	-0.0058 (0.0058)	0.0035 (0.0024)
regionNorth City:pct_black	-0.0077 (0.0105)	-0.0135*** (0.0031)
regionNorth County:pct_black	-0.0042 (0.0053)	-0.0058*** (0.0020)
regionFirst Suburb:periodBoom	-0.2456 (0.3241)	0.1046 (0.1518)
regionNorth City:periodBoom	-0.4280 (0.3683)	-0.0969 (0.1758)
regionNorth County:periodBoom	-0.3200 (0.2180)	-0.0363 (0.1033)
regionFirst Suburb:periodPost-boom	-0.3480 (0.5073)	-0.2600 (0.2072)
regionNorth City:periodPost-boom	-0.7558 (0.5611)	0.1412 (0.1950)
regionNorth County:periodPost-boom	-0.5041* (0.2860)	-0.3750*** (0.1158)
fico_score_at_origination:regionFirst Suburb	0.0018** (0.0008)	-0.0016*** (0.0004)
fico_score_at_origination:regionNorth City	0.0037*** (0.0009)	0.0002 (0.0004)

fico_score_at_origination:regionNorth County	0.0020***				-0.0010***
	(0.0006)				(0.0003)
regionFirst Suburb:unemployment_rate	-0.0029				-0.0194
	(0.0610)				(0.0260)
regionNorth City:unemployment_rate	0.0012				0.0045
	(0.0329)				(0.0107)
regionNorth County:unemployment_rate	-0.0294				0.0402***
	(0.0285)				(0.0111)
Observations	315,972	315,972	315,972	315,972	315,972
Log Likelihood	-10,447.8200	-10,381.7700	-78,359.1900	-77,662.2600	-74,797.0100
Akaike Inf. Crit.	20,929.6400	20,851.5500	156,734.4000	155,348.5000	149,682.0000
Note:					*p<0.1; **p<0.05; ***p<0.01

The opposite effect appeared for ARMs, with lower FICO scores pushing South County/South City borrowers to the risky loan more than for First Suburb or North County borrowers. This may be deceiving, though, as the margins for those in the southern portions of St. Louis were typically much smaller than those for those in the northern parts. Also, the odds of receiving an ARM increased with the percentage of Black residents in the ZCTA. Model (5) also shows that an additional percentage point of Black residents was associated with 0.7% increased odds of receiving an ARM in South County/South City. Race was just as important in the First Suburbs but actually less important in the other Black areas of St. Louis, namely North City and North County. In fact, in North City, a higher proportion of Black residents was associated with a decrease in the odds of receiving an ARM. This analysis is consistent with the exploratory data analysis shown earlier in Figure 7.

Clearly, Black neighborhoods in North St. Louis City and its bordering First Suburb regions bore the brunt of the subprime boom. These northern regions alongside the rest of North County saw especially high rates of balloon loans compared to South County and South City. However, South County and South City saw ARMs at similarly high frequencies as the rest of the St. Louis area.

So how did these differences in the subprime boom translate to borrower payment delinquency and foreclosure? This is the question the next section attempts to provide an answer.

#### *Results for Question 2 (Borrower Payment Delinquency and Foreclosure)*

Studying Question 1 revealed that the First Suburbs and North City received an inordinately large share of subprime home loans given their borrowers' creditworthiness. Question 2 concerns how these loans' subprime status translated to foreclosure and borrower payment delinquency. This analysis examines three dependent variables: whether the home was foreclosed on (IV), whether the loan was in 60-day delinquency (V), and whether the loan was in 90-day delinquency (V). The models reveal that whether a loan was subprime substantially increased the likelihood of borrower payment delinquency and foreclosure. The impact was far larger for balloon loans than ARMs, perhaps because ARMs were issued with a less discriminatory eye toward race. One other possible

explanation for this is that borrowers who intend to flip the home may opt for an ARM because they will sell the house quickly and avoid the higher interest rates many years later.

Table 7 displays the results of the logit model of foreclosure and its potential drivers. The CoreLogic indicator variable of a loan's subprime status, shown as *subprime* below, seems to be a significant factor in driving foreclosure, even after accounting for race, region, FICO score and other demographic factors. Models (2) and (3) demonstrate that a loan being subprime increases the odds of being foreclosed on by between 32% and 33% with all other variables held constant.

This effect varies wildly by the type of subprime loan, however. Models (5) and (6) reveal that an ARM actually reduced the odds of foreclosure by between 23% and 24% with all other variables held constant. Meanwhile, a balloon loan increased the odds of foreclosure by more than 170% with other variables held constant. This remarkable difference may be the result of the more equal distribution of ARMs across St. Louis compared to balloon loans, as illustrated in Figure 7. The effect of being subprime is the same across all regions, though this is not shown in Table 7 for space reasons.

FICO score again impacted foreclosure along with subprime status. While FICO score does not affect foreclosure directly, its influence in determining a loan's terms can make it more difficult for borrowers to make payments. A lower FICO score may lead to less favorable terms which pervade different types and structures of loan. Including FICO score in these models will help the logistic regression pick up on more incremental differences in the terms of loans not caught by the subprime, ARM, and balloon indicator variables.

A higher FICO score leads to a reduced chance of foreclosure in South County/South City. However, it seems to have a much smaller impact on foreclosure in the northern regions of St. Louis. In Model (2), a one-point increase in FICO score is associated with a 0.7% reduction in the odds of a foreclosure in South County/South City. The same increase is associated with only a 0.02% reduction in the odds of a foreclosure in the First Suburbs. In North City, an increase in FICO score is actually associated with a statistically significant increase in the likelihood of foreclosure in this model. That model treated subprime as one indicator variable, but the other models with variables for ARMs and balloon loans corroborate this finding.

While no region sees an increased chance for foreclosure from a one-point jump in FICO score in Model (5), the higher FICO score does much less to the likelihood of foreclosure in northern regions. Model (5) in Table 7 predicts that a one-point increase in FICO score reduces the odds of foreclosure by 0.8% in South County/South City with other variables held constant. The same model sees only a 0.2% reduction in the First Suburbs and just a 0.1% reduction in North City. Even after accounting for "subprimeness" in the loan, the terms of the loan driven by FICO score push foreclosure primarily in Black neighborhoods in the First Suburbs and North City.

**Table 7***Results from logit models (IV) of demographic factors' and subprime status' impacts on foreclosure*

	<i>Dependent variable:</i>					
	foreclosure					
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	-2.7688*	-7.9549*	-7.3687*	-2.0761	-7.0795	-6.5359
	(1.4940)	(4.3764)	(4.3988)	(1.4162)	(4.3449)	(4.3708)
fico_score_at_origination	-0.0080***	-0.0066**	-0.0076***	-0.0089***	-0.0078***	-0.0088***
	(0.0009)	(0.0026)	(0.0026)	(0.0006)	(0.0025)	(0.0026)
back_end_ratio	0.0045*	0.0035	0.0034	0.0041	0.0030	0.0029
	(0.0027)	(0.0027)	(0.0027)	(0.0027)	(0.0028)	(0.0028)
regionFirst Suburb	0.7358***	-7.7199	-3.3501	0.7172***	-7.3777	-3.2051
	(0.2183)	(5.5821)	(5.3074)	(0.2192)	(5.4819)	(5.2223)
regionNorth City	-0.0301	-9.3546***	-4.3699**	-0.0380	-9.0830***	-4.3565**
	(0.2562)	(2.5420)	(1.9913)	(0.2573)	(2.5406)	(1.9965)
regionNorth County	0.7410***	-6.5809***	-4.4713***	0.7246***	-6.4504***	-4.4641***
	(0.1266)	(1.8525)	(1.6529)	(0.1267)	(1.8539)	(1.6539)
periodBoom	0.2139	6.0163	5.5803	0.2123	6.0157	5.5987
	(0.2217)	(4.1339)	(4.1364)	(0.2222)	(4.1242)	(4.1307)
periodPost-boom	0.2356	9.8894**	9.1072**	0.2066	9.7990**	9.0565**
	(0.2276)	(4.0999)	(4.1076)	(0.2287)	(4.0922)	(4.1041)
pct_black	0.0003	0.0392*	-0.0135	0.0001	0.0396*	-0.0105
	(0.0039)	(0.0209)	(0.0239)	(0.0039)	(0.0210)	(0.0241)
unemployment_rate	0.0222	-0.0217	-0.0169	0.0251	-0.0180	-0.0136
	(0.0237)	(0.1126)	(0.1125)	(0.0238)	(0.1123)	(0.1122)
median_age	0.0293	0.0220	0.0232	0.0297	0.0229	0.0241
	(0.0253)	(0.0299)	(0.0300)	(0.0254)	(0.0299)	(0.0300)
pct_home_ownership	-0.0200**	0.0215	0.0221	-0.0198**	0.0209	0.0218
	(0.0086)	(0.0495)	(0.0494)	(0.0086)	(0.0493)	(0.0492)
avg_household_size	0.6719	0.6858	0.7215	0.6836	0.6926	0.7296
	(0.4576)	(0.6032)	(0.6046)	(0.4579)	(0.6043)	(0.6056)
median_gross_rent	-0.0004	0.0002	0.0003	-0.0004	0.0003	0.0003
	(0.0006)	(0.0007)	(0.0007)	(0.0006)	(0.0007)	(0.0007)
median_income_1999	-0.0169***	-0.0551	-0.0538	-0.0163**	-0.0541	-0.0527
	(0.0064)	(0.0395)	(0.0394)	(0.0064)	(0.0392)	(0.0390)
pct_married	3.7453*	11.6205	11.1868	3.5001*	11.4782	11.0168
	(1.9699)	(10.4967)	(10.5282)	(1.9754)	(10.4702)	(10.5077)
subprime	0.2162	0.2862**	0.2770*			
	(0.1507)	(0.1428)	(0.1425)			

periodBoom:unemployment_rate	0.0492 (0.1096)	0.0479 (0.1096)	0.0507 (0.1094)	0.0492 (0.1094)
periodPost-boom:unemployment_rate	0.0506 (0.1093)	0.0527 (0.1092)	0.0480 (0.1090)	0.0499 (0.1089)
periodBoom:pct_home_ownership	-0.0845* (0.0495)	-0.0849* (0.0493)	-0.0834* (0.0493)	-0.0843* (0.0492)
periodPost-boom:pct_home_ownership	-0.0490 (0.0490)	-0.0494 (0.0488)	-0.0484 (0.0488)	-0.0489 (0.0486)
periodBoom:pct_black	-0.0522** (0.0206)	-0.0525** (0.0207)	-0.0535*** (0.0207)	-0.0538*** (0.0208)
periodPost-boom:pct_black	-0.0519** (0.0204)	-0.0558*** (0.0205)	-0.0522** (0.0205)	-0.0560*** (0.0206)
periodBoom:pct_married	-7.1290 (10.8975)	-6.8711 (10.9299)	-7.5128 (10.8740)	-7.1845 (10.9116)
periodPost-boom:pct_married	-6.7755 (10.7555)	-6.4718 (10.7876)	-6.6210 (10.7291)	-6.3117 (10.7677)
periodBoom:median_income_1999	0.0580 (0.0397)	0.0566 (0.0396)	0.0584 (0.0393)	0.0569 (0.0392)
periodPost-boom:median_income_1999	0.0256 (0.0396)	0.0245 (0.0395)	0.0248 (0.0393)	0.0236 (0.0391)
fico_score_at_origination:periodBoom	-0.0001 (0.0025)	0.0006 (0.0025)	0.00003 (0.0025)	0.0007 (0.0025)
fico_score_at_origination:periodPost-boom	-0.0073*** (0.0025)	-0.0062** (0.0025)	-0.0072*** (0.0025)	-0.0062** (0.0025)
regionFirst Suburb:pct_black	0.0179 (0.0347)	0.0174 (0.0332)	0.0170 (0.0335)	0.0164 (0.0322)
regionNorth City:pct_black	0.0066 (0.0209)	0.0035 (0.0208)	0.0060 (0.0208)	0.0032 (0.0208)
regionNorth County:pct_black	0.0136 (0.0116)	0.0149 (0.0116)	0.0134 (0.0116)	0.0145 (0.0116)
regionFirst Suburb:periodBoom	2.7041** (1.1927)	2.7530** (1.1914)	2.7475** (1.1990)	2.8006** (1.1975)
regionNorth City:periodBoom	3.2907** (1.5583)	3.3262** (1.5519)	3.3427** (1.5656)	3.3798** (1.5593)
regionNorth County:periodBoom	1.9572** (0.9792)	1.9789** (0.9811)	1.9842** (0.9789)	2.0035** (0.9801)
regionFirst Suburb:periodPost-boom	2.9314** (1.1843)	3.2397*** (1.1817)	3.0035** (1.1900)	3.2981*** (1.1872)

regionNorth City:periodPost-boom	3.6640**	4.0103***		3.7554**	4.0847***
	(1.5564)	(1.5491)		(1.5629)	(1.5558)
regionNorth County:periodPost-boom	2.3948**	2.5531***		2.4521**	2.5980***
	(0.9708)	(0.9713)		(0.9703)	(0.9701)
fico_score_at_origination:regionFirst Suburb	0.0064***			0.0061***	
	(0.0016)			(0.0016)	
fico_score_at_origination:regionNorth City	0.0074***			0.0070***	
	(0.0021)			(0.0021)	
fico_score_at_origination:regionNorth County	0.0032**			0.0030**	
	(0.0012)			(0.0012)	
fico_score_at_origination:pct_black		0.0001***			0.0001***
		(0.00002)			(0.00002)
regionFirst Suburb:unemployment_rate	-0.0300	-0.0304		-0.0299	-0.0301
	(0.1658)	(0.1576)		(0.1595)	(0.1521)
regionNorth City:unemployment_rate	-0.0208	-0.0233		-0.0243	-0.0266
	(0.0710)	(0.0705)		(0.0711)	(0.0706)
regionNorth County:unemployment_rate	0.0402	0.0340		0.0406	0.0346
	(0.0613)	(0.0614)		(0.0613)	(0.0613)
regionFirst Suburb:pct_home_ownership	0.0221	0.0168		0.0197	0.0146
	(0.0722)	(0.0693)		(0.0700)	(0.0675)
regionNorth City:pct_home_ownership	0.0363**	0.0352**		0.0362**	0.0352**
	(0.0167)	(0.0168)		(0.0168)	(0.0168)
regionNorth County:pct_home_ownership	0.0321**	0.0310**		0.0315**	0.0303**
	(0.0138)	(0.0138)		(0.0139)	(0.0139)
arm				-0.3894**	-0.2637*
				(0.1529)	(0.1544)
balloon				0.9046***	0.9964***
				(0.1870)	(0.1867)
Observations	171,540	171,540	171,540	171,540	171,540
Log Likelihood	-3,438.8760	-3,355.4990	-3,357.3450	-3,425.9570	-3,343.8580
Akaike Inf. Crit.	6,911.7520	6,804.9990	6,804.6910	6,887.9150	6,782.9850

Note:

\* p<0.1; \*\* p<0.05; \*\*\* p<0.01

The same results appear for the other two dependent variables, 60-day delinquency and 90-day delinquency. Subprime status is a strong predictor of borrower payment delinquency with balloon loans drastically increasing the chances of delinquency. Like in the foreclosure models, ARMs reduce the likelihood of payment delinquency. A higher FICO score leads to a reduced chance of payment delinquency in White neighborhoods but is a less strong predictor in Black neighborhoods, likely reflecting the differential terms of the loans.

Table 8 displays the results of the logit model for 60-day borrower payment delinquency, and Table 9 displays the results of the logit model for 90-day delinquency. These are less harsh consequences than foreclosure—they can be interpreted as measures of default—but many of the same trends appear among their predictors. The effect of a one-point increase in FICO score is more than halved in the First Suburb and North City regions for both 60- and 90-day delinquencies compared to loans originated in St. Louis' southern regions.

The effect of ARM and balloon status remained the same for these payment delinquencies, as well. An ARM was associated with a 16% reduction in odds of 60-day payment delinquency with all other variables held constant, while a balloon loan was associated with an 83% increase in the odds of 60-day delinquency. Likewise, an ARM reduces the odds of 90-day delinquency by 4% and a balloon loan increases the odds by 110% with all other variables held constant.

In any case, subprime status had a strong impact on the likelihood of foreclosure. The more specific terms of the loans likely had an even bigger hand in determining foreclosure, with worse terms in more Black St. Louis neighborhoods. As a result, foreclosure rates were higher in North City, the First Suburbs, and other North County ZCTAs. The last question remains how much these differences in foreclosure affected home vacancy. This is the question the last section of analysis tackles.

**Table 8**

Results from logit models (*V*) of demographic factors' and subprime status' impacts on 60-day borrower payment delinquency as defined by the Mortgage Bankers Association

	<i>Dependent variable:</i>					
	sixty_day_delinquent					
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	2.1031** (0.9812)	-0.0396 (2.2757)	-0.1754 (2.2785)	2.6167*** (0.9268)	0.6153 (2.2493)	0.4550 (2.2519)
fico_score_at_origination	-0.0094*** (0.0006)	-0.0069*** (0.0015)	-0.0068*** (0.0015)	-0.0101*** (0.0004)	-0.0078*** (0.0014)	-0.0076*** (0.0014)
back_end_ratio	0.0022 (0.0018)	0.0015 (0.0018)	0.0015 (0.0018)	0.0018 (0.0018)	0.0012 (0.0019)	0.0011 (0.0018)
regionFirst Suburb	0.3971*** (0.1491)	0.8296 (3.7880)	3.6571 (3.6212)	0.3860*** (0.1496)	1.0873 (3.7574)	3.8184 (3.5957)
regionNorth City	0.2107 (0.1722)	-3.7932*** (1.4106)	-0.9207 (1.0362)	0.2054 (0.1729)	-3.5709** (1.4064)	-0.8657 (1.0382)
regionNorth County	0.5279*** (0.0849)	-1.5964 (1.1070)	-0.3020 (0.9588)	0.5153*** (0.0850)	-1.5298 (1.1071)	-0.3000 (0.9593)
periodBoom	0.0971 (0.1216)	3.5433* (2.0120)	3.5151* (2.0072)	0.1007 (0.1219)	3.4644* (2.0069)	3.4390* (2.0032)
periodPost-boom	-0.6949*** (0.1301)	5.7843*** (2.0393)	5.7207*** (2.0393)	-0.7214*** (0.1306)	5.6587*** (2.0362)	5.6017*** (2.0372)
pct_black	0.0003 (0.0026)	-0.0029 (0.0111)	-0.0297** (0.0135)	0.0001 (0.0026)	-0.0027 (0.0111)	-0.0281** (0.0135)
unemployment_rate	0.0055 (0.0160)	0.1083* (0.0605)	0.1114* (0.0603)	0.0075 (0.0160)	0.1080* (0.0604)	0.1108* (0.0603)
median_age	-0.00002 (0.0169)	-0.0245 (0.0195)	-0.0240 (0.0195)	0.0002 (0.0169)	-0.0235 (0.0195)	-0.0231 (0.0196)
pct_home_ownership	-0.0037 (0.0057)	-0.0289 (0.0233)	-0.0275 (0.0232)	-0.0037 (0.0057)	-0.0288 (0.0233)	-0.0274 (0.0232)
avg_household_size	-0.0372 (0.3100)	-0.3636 (0.3895)	-0.3532 (0.3896)	-0.0286 (0.3103)	-0.3483 (0.3900)	-0.3376 (0.3900)
median_gross_rent	-0.0014*** (0.0004)	-0.0009* (0.0004)	-0.0008* (0.0004)	-0.0013*** (0.0004)	-0.0008* (0.0004)	-0.0008* (0.0004)
median_income_1999	-0.0051 (0.0039)	0.0067 (0.0164)	0.0068 (0.0164)	-0.0046 (0.0039)	0.0068 (0.0163)	0.0069 (0.0163)
pct_married	2.7866** (1.2891)	6.3661 (5.4173)	6.0968 (5.4056)	2.6177** (1.2915)	6.2440 (5.4112)	5.9788 (5.4019)
subprime	0.1459 (0.1007)	0.1888** (0.0960)	0.1810* (0.0958)			

periodBoom:unemployment_rate	-0.1137** (0.0579)	-0.1150** (0.0577)	-0.1113* (0.0579)	-0.1124* (0.0577)
periodPost-boom:unemployment_rate	-0.0490 (0.0599)	-0.0489 (0.0597)	-0.0485 (0.0598)	-0.0484 (0.0597)
periodBoom:pct_home_ownership	0.0275 (0.0227)	0.0266 (0.0227)	0.0279 (0.0227)	0.0269 (0.0227)
periodPost-boom:pct_home_ownership	0.0230 (0.0229)	0.0220 (0.0229)	0.0231 (0.0229)	0.0221 (0.0229)
periodBoom:pct_black	0.0005 (0.0102)	0.0011 (0.0102)	0.0001 (0.0102)	0.0007 (0.0102)
periodPost-boom:pct_black	-0.0068 (0.0105)	-0.0085 (0.0105)	-0.0068 (0.0105)	-0.0085 (0.0105)
periodBoom:pct_married	-5.5441 (5.6601)	-5.3289 (5.6479)	-5.7287 (5.6566)	-5.5097 (5.6467)
periodPost-boom:pct_married	-2.2014 (5.6714)	-1.9811 (5.6599)	-2.1233 (5.6669)	-1.9090 (5.6577)
periodBoom:median_income_1999	-0.0020 (0.0166)	-0.0022 (0.0166)	-0.0014 (0.0166)	-0.0016 (0.0165)
periodPost-boom:median_income_1999	-0.0164 (0.0168)	-0.0165 (0.0167)	-0.0164 (0.0167)	-0.0165 (0.0167)
fico_score_at_origination:periodBoom	-0.0017 (0.0014)	-0.0017 (0.0014)	-0.0016 (0.0014)	-0.0016 (0.0014)
fico_score_at_origination:periodPost-boom	-0.0078*** (0.0014)	-0.0078*** (0.0014)	-0.0078*** (0.0014)	-0.0078*** (0.0014)
regionFirst Suburb:pct_black	0.0027 (0.0251)	0.0015 (0.0243)	0.0015 (0.0247)	0.0003 (0.0240)
regionNorth City:pct_black	-0.0060 (0.0142)	-0.0078 (0.0141)	-0.0064 (0.0142)	-0.0081 (0.0141)
regionNorth County:pct_black	0.0130* (0.0075)	0.0131* (0.0075)	0.0127* (0.0075)	0.0127* (0.0075)
regionFirst Suburb:periodBoom	-0.3553 (0.5444)	-0.3703 (0.5433)	-0.3540 (0.5453)	-0.3659 (0.5444)
regionNorth City:periodBoom	1.1073 (0.6906)	1.0948 (0.6868)	1.1058 (0.6928)	1.0960 (0.6893)
regionNorth County:periodBoom	-0.2279 (0.3973)	-0.2419 (0.3969)	-0.2177 (0.3968)	-0.2297 (0.3963)
regionFirst Suburb:periodPost-boom	0.0189 (0.5657)	0.2033 (0.5632)	0.0387 (0.5663)	0.2167 (0.5640)
regionNorth City:periodPost-boom	0.9171 (0.7262)	1.1301 (0.7212)	0.9391 (0.7278)	1.1414 (0.7232)

regionNorth County:periodPost-boom	0.0389 (0.3996)	0.1239 (0.3980)		0.0691 (0.3990)	0.1501 (0.3974)
fico_score_at_origination:regionFirst Suburb	0.0040*** (0.0011)			0.0039*** (0.0011)	
fico_score_at_origination:regionNorth City	0.0043*** (0.0013)			0.0041*** (0.0013)	
fico_score_at_origination:regionNorth County	0.0019** (0.0008)			0.0018** (0.0008)	
fico_score_at_origination:pct_black		0.00004*** (0.00001)			0.00004*** (0.00001)
regionFirst Suburb:unemployment_rate	-0.1026 (0.1218)	-0.1015 (0.1176)		-0.0995 (0.1199)	-0.0983 (0.1159)
regionNorth City:unemployment_rate	0.0538 (0.0473)	0.0525 (0.0471)		0.0517 (0.0474)	0.0505 (0.0472)
regionNorth County:unemployment_rate	-0.0340 (0.0422)	-0.0364 (0.0422)		-0.0321 (0.0422)	-0.0344 (0.0422)
regionFirst Suburb:pct_home_ownership	-0.0163 (0.0512)	-0.0206 (0.0497)		-0.0186 (0.0506)	-0.0229 (0.0492)
regionNorth City:pct_home_ownership	-0.0026 (0.0105)	-0.0034 (0.0105)		-0.0028 (0.0105)	-0.0035 (0.0105)
regionNorth County:pct_home_ownership	0.0121 (0.0089)	0.0114 (0.0089)		0.0116 (0.0089)	0.0108 (0.0089)
arm			-0.2542*** (0.0844)	-0.1700** (0.0848)	-0.1721** (0.0848)
balloon			0.5557*** (0.1240)	0.6056*** (0.1232)	0.6067*** (0.1232)
Observations	171,540	171,540	171,540	171,540	171,540
Log Likelihood	-6,638.5360	-6,538.8160	-6,542.8940	-6,624.9250	-6,527.3260
Akaike Inf. Crit.	13,311.0700	13,171.6300	13,175.7900	13,285.8500	13,150.6500

Note:

\* p<0.1; \*\* p<0.05; \*\*\* p<0.01

**Table 9**

*Results from logit models (VI) of demographic factors' and subprime status' impacts on 90-day borrower payment delinquency as defined by the Mortgage Bankers Association*

	Dependent variable:					
	ninety_day_delinquent					
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	1.3142 (0.8864)	0.5077 (1.9638)	0.8480 (1.9646)	1.0869 (0.8386)	0.4974 (1.9420)	0.8214 (1.9426)
fico_score_at_origination	-0.0093*** (0.0005)	-0.0064*** (0.0013)	-0.0069*** (0.0013)	-0.0090*** (0.0003)	-0.0065*** (0.0012)	-0.0069*** (0.0012)
back_end_ratio	0.0029* (0.0016)	0.0022 (0.0016)	0.0022 (0.0016)	0.0028* (0.0016)	0.0021 (0.0016)	0.0020 (0.0016)
regionFirst Suburb	0.3247** (0.1320)	-0.5415 (3.7675)	1.6670 (3.6643)	0.3176** (0.1324)	-0.2271 (3.7188)	1.9400 (3.6131)
regionNorth City	-0.0444 (0.1552)	-2.7410** (1.2860)	0.3973 (0.9499)	-0.0496 (0.1556)	-2.5694** (1.2856)	0.4253 (0.9507)
regionNorth County	0.5498*** (0.0761)	-2.6853*** (0.9988)	-1.0985 (0.8652)	0.5416*** (0.0762)	-2.6707*** (0.9989)	-1.0885 (0.8657)
periodBoom	-0.0292 (0.1072)	0.1810 (1.7447)	0.0645 (1.7381)	-0.0408 (0.1075)	0.1517 (1.7422)	0.0292 (1.7364)
periodPost-boom	-0.6290*** (0.1135)	4.4003** (1.7571)	4.1211** (1.7524)	-0.6200*** (0.1142)	4.4671** (1.7560)	4.1804** (1.7521)
pct_black	0.0092*** (0.0022)	0.0214** (0.0095)	-0.0167 (0.0118)	0.0090*** (0.0023)	0.0217** (0.0096)	-0.0156 (0.0118)
unemployment_rate	-0.0107 (0.0144)	-0.0463 (0.0545)	-0.0442 (0.0544)	-0.0090 (0.0144)	-0.0470 (0.0545)	-0.0453 (0.0544)
median_age	0.0117 (0.0150)	-0.0017 (0.0173)	-0.0015 (0.0173)	0.0122 (0.0150)	-0.0013 (0.0173)	-0.0010 (0.0173)
pct_home_ownership	-0.0007 (0.0052)	0.0117 (0.0227)	0.0133 (0.0226)	-0.0007 (0.0052)	0.0111 (0.0227)	0.0128 (0.0227)
avg_household_size	0.0733 (0.2780)	-0.4915 (0.3439)	-0.4747 (0.3438)	0.0824 (0.2781)	-0.4861 (0.3442)	-0.4679 (0.3442)
median_gross_rent	-0.0012*** (0.0003)	-0.0006 (0.0004)	-0.0005 (0.0004)	-0.0011*** (0.0003)	-0.0006 (0.0004)	-0.0005 (0.0004)
median_income_1999	-0.0101*** (0.0036)	0.0002 (0.0148)	0.0008 (0.0148)	-0.0099*** (0.0036)	-0.0003 (0.0147)	0.0003 (0.0147)
pct_married	3.2473*** (1.1521)	1.1849 (5.2593)	0.7243 (5.2518)	3.1268*** (1.1538)	1.3569 (5.2535)	0.8752 (5.2479)
subprime	-0.0570 (0.0896)	0.0325 (0.0855)	0.0288 (0.0853)			

periodBoom:unemployment_rate	0.0819 (0.0521)	0.0807 (0.0520)	0.0846 (0.0521)	0.0837 (0.0520)
periodPost-boom:unemployment_rate	0.0824 (0.0531)	0.0845 (0.0530)	0.0825 (0.0531)	0.0850 (0.0530)
periodBoom:pct_home_ownership	-0.0179 (0.0221)	-0.0191 (0.0221)	-0.0169 (0.0221)	-0.0183 (0.0221)
periodPost-boom:pct_home_ownership	-0.0063 (0.0221)	-0.0075 (0.0221)	-0.0054 (0.0221)	-0.0066 (0.0221)
periodBoom:pct_black	-0.0086 (0.0089)	-0.0077 (0.0089)	-0.0093 (0.0089)	-0.0084 (0.0089)
periodPost-boom:pct_black	-0.0060 (0.0090)	-0.0083 (0.0090)	-0.0062 (0.0090)	-0.0084 (0.0090)
periodBoom:pct_married	4.9010 (5.4650)	5.2481 (5.4577)	4.5143 (5.4614)	4.8919 (5.4559)
periodPost-boom:pct_married	1.3108 (5.4346)	1.6603 (5.4275)	1.1122 (5.4302)	1.4784 (5.4249)
periodBoom:median_income_1999	-0.0080 (0.0151)	-0.0087 (0.0151)	-0.0070 (0.0150)	-0.0078 (0.0150)
periodPost-boom:median_income_1999	-0.0084 (0.0150)	-0.0089 (0.0150)	-0.0079 (0.0149)	-0.0084 (0.0148)
fico_score_at_origination:periodBoom	-0.0020* (0.0012)	-0.0019 (0.0012)	-0.0019 (0.0012)	-0.0018 (0.0012)
fico_score_at_origination:periodPost-boom	-0.0080*** (0.0012)	-0.0078*** (0.0012)	-0.0081*** (0.0013)	-0.0078*** (0.0013)
regionFirst Suburb:pct_black	-0.0012 (0.0270)	-0.0011 (0.0266)	-0.0029 (0.0264)	-0.0028 (0.0261)
regionNorth City:pct_black	0.0074 (0.0140)	0.0059 (0.0139)	0.0073 (0.0139)	0.0059 (0.0139)
regionNorth County:pct_black	-0.0049 (0.0065)	-0.0043 (0.0065)	-0.0050 (0.0065)	-0.0044 (0.0065)
regionFirst Suburb:periodBoom	-0.5080 (0.4696)	-0.5285 (0.4692)	-0.5164 (0.4708)	-0.5357 (0.4705)
regionNorth City:periodBoom	-0.6919 (0.5588)	-0.7207 (0.5564)	-0.6953 (0.5608)	-0.7233 (0.5587)
regionNorth County:periodBoom	-0.2596 (0.3463)	-0.2918 (0.3462)	-0.2493 (0.3460)	-0.2812 (0.3459)
regionFirst Suburb:periodPost-boom	-0.4117 (0.4804)	-0.2572 (0.4787)	-0.4114 (0.4813)	-0.2614 (0.4799)
regionNorth City:periodPost-boom	-1.1423** (0.5773)	-0.9239 (0.5722)	-1.1251* (0.5788)	-0.9165 (0.5741)

regionNorth County:periodPost-boom	0.1000 (0.3452)	0.1858 (0.3444)	0.1229 (0.3449)	0.2071 (0.3441)
fico_score_at_origination:regionFirst Suburb	0.0033*** (0.0010)		0.0033*** (0.0010)	
fico_score_at_origination:regionNorth City	0.0047*** (0.0012)		0.0045*** (0.0012)	
fico_score_at_origination:regionNorth County	0.0024*** (0.0007)		0.0024*** (0.0007)	
fico_score_at_origination:pct_black		0.0001*** (0.00001)		0.0001*** (0.00001)
regionFirst Suburb:unemployment_rate	-0.0895 (0.1352)	-0.0860 (0.1334)	-0.0843 (0.1322)	-0.0807 (0.1304)
regionNorth City:unemployment_rate	-0.0229 (0.0440)	-0.0223 (0.0438)	-0.0242 (0.0440)	-0.0235 (0.0438)
regionNorth County:unemployment_rate	0.0211 (0.0369)	0.0185 (0.0369)	0.0220 (0.0369)	0.0193 (0.0369)
regionFirst Suburb:pct_home_ownership	0.0036 (0.0537)	0.0009 (0.0531)	-0.0001 (0.0527)	-0.0027 (0.0521)
regionNorth City:pct_home_ownership	-0.0055 (0.0096)	-0.0063 (0.0097)	-0.0057 (0.0097)	-0.0065 (0.0097)
regionNorth County:pct_home_ownership	0.0192** (0.0082)	0.0184** (0.0082)	0.0188** (0.0082)	0.0179** (0.0082)
arm			-0.1400* (0.0763)	-0.0359 (0.0766)
balloon			0.6951*** (0.1111)	0.7427*** (0.1100)
Observations	171,540	171,540	171,540	171,540
Log Likelihood	-8,190.6240	-8,056.1770	-8,053.3310	-8,171.2270
Akaike Inf. Crit.	16,415.2500	16,206.3500	16,196.6600	16,378.4500
			16,168.6500	16,159.0000

Note:

\* p<0.1; \*\* p<0.05; \*\*\* p<0.01

### *Results for Question 3 (Home Vacancy)*

Question 3 looked at how much borrower payment delinquency and demographic factors explain home vacancy in St. Louis area neighborhoods. Table 10 presents the results of five linear regression models built on the percent of vacant homes in each ZCTA. The aggregation over ZCTA limits the number of observations to only 62, but goodness-of-fit appears little issue. Model (5) is the result of backward selection with AIC as the criterion.

Foreclosure appears a strong predictor of home vacancy in Model (1), with a one percentage point increase in foreclosure leading to a 13.7 percentage point increase in the percentage of vacant homes in South County and South City ZCTAs. However, this effect was erased in First Suburb and other North County ZCTAs. Race also seems to play a major role in this model. Each additional percent Black increases expected home vacancy by 0.14 points with other variables held constant.

These two variables fall away when controlling for other demographic factors, though. The model with the highest adjusted R-squared value, Model (5), finds 60-day delinquency as the only significant main effect for borrower payment delinquency. Every additional percentage point of a ZCTA's home loans that are 60 days delinquent on payments sees a 3.44 percentage point jump in home vacancy with other variables held constant. This result does not vary by region or race.

The 60-day delinquency measure can be treated as a measure of default, as many lenders treat a lack of payment for about 60 days as their threshold for default. Region itself is significant, but this is tempered by the interaction between foreclosure and region. For instance, Model (5) shows a nearly 12 percentage point bump in expected home vacancy for First Suburb homes, but an increase in foreclosure is associated with a reduction in expected home vacancy, holding other variables constant.

It seems the main drivers of home vacancy in these models are FICO score and back-end ratio. A one-point increase in a ZCTA's mean FICO score reduces expected home vacancy by 0.096 percentage points, with other variables held constant. A one-unit increase in back-end ratio reduces expected home vacancy by 1.39 percentage points. These two variables were significant at the five percent significance threshold or lower in all models depicted in Table 10.

It also seems important to note the limited number of observations in this model. There are 62 observations at one per ZIP code, so very few predictors will be significant. This means that the relationships these models found must be taken with a grain of salt, but also that significant predictors like FICO score and back-end ratio are highly correlated with home vacancy.

These effects also did not vary across region or race, rather working through intermediate variables. This is probably because these models included measures of borrower payment delinquency. The 60-day delinquency variable likely “soaks up” much of the effect of subprime lending, since subprime status was a strong predictor of delinquency. The constant effect of mean FICO score on home vacancy picks up on one- or two-point nuances that the dummy variables like delinquency measures cannot.

Back-end ratio also played a constant role across region and race. This may reflect the availability of jobs in the area. However, unemployment rate did not have a significant effect in the other models in Table 10. It is more probable that back-end ratio is significant because it is a strong predictor of subprime loans—and risky balloon loans in particular.

**Table 10**

*Results from linear regression models (VII) of borrower payment delinquency and demographic factors' impacts on home vacancy in St. Louis*

	<i>Dependent variable:</i>				
	Percent_Vacant				
	(1)	(2)	(3)	(4)	(5)
Constant	3.2936*** (0.9781)	210.5284** (81.8640)	198.8376* (103.0549)	183.2717*** (53.9500)	123.5527*** (34.2700)
pct_foreclosed	13.7277*** (4.5310)	4.3115 (6.8667)	0.0924 (8.1792)	1.7129 (6.4131)	6.1213 (4.3662)
pct_sixty_day_delinquent				4.5790* (2.4745)	3.4396** (1.6535)
pct_ninety_day_delinquent				0.2434 (1.8532)	
pct_black	0.1382*** (0.0476)	0.0845* (0.0478)	-0.0160 (0.0658)	-0.0063 (0.0684)	
regionFirst Suburb	8.3787 (10.9833)	95.0763 (275.8612)	185.5866 (287.0920)	15.3524 (13.9159)	11.8312** (5.6575)
regionNorth City	0.1498 (4.6527)	-27.0552 (80.1551)	12.7326 (102.7412)	15.5631* (8.1787)	4.4327 (3.4932)
regionNorth County	2.4699 (2.6113)	-52.5942 (120.3607)	-76.6243 (128.4105)	0.0296 (2.9445)	1.6714 (2.4678)
mean_fico_score		-0.2127** (0.0893)	-0.2149* (0.1220)	-0.1746** (0.0681)	-0.0956** (0.0363)
mean_back_end_ratio		-1.4466** (0.6503)	-1.3343* (0.7506)	-1.7402* (0.9205)	-1.3927*** (0.4780)
unemployment_rate			0.0028 (0.3275)	-0.3650 (0.3876)	
median_age			0.2637 (0.2204)	0.2335 (0.2207)	
pct_home_ownership			-0.1525 (0.0908)	-0.1558* (0.0889)	-0.1408*** (0.0444)
avg_household_size			8.6579 (5.1924)	8.5911 (5.5226)	3.1554 (2.1350)
median_gross_rent			0.0008 (0.0040)	0.0006 (0.0038)	
median_income_1999			0.00001 (0.00005)	-0.00001 (0.00005)	

pct_married			-18.2694 (18.0525)	-14.6655 (16.9858)	
pct_foreclosed:regionFirst Suburb	-14.6940* (7.4624)	-14.9528 (11.4195)	-7.4410 (14.4130)	-20.9623 (15.6388)	-16.3261** (7.6680)
pct_foreclosed:regionNorth City	-8.7024 (7.0309)	-0.5503 (8.3914)	7.9102 (10.4438)	6.3895 (8.8490)	-0.9094 (6.0615)
pct_foreclosed:regionNorth County	-12.2076* (6.9195)	-4.9263 (8.6480)	-2.6985 (9.7093)	-3.2105 (7.6200)	-8.3537* (4.4451)
pct_black:regionFirst Suburb	-0.0211 (0.1272)	-0.1429 (0.2498)	-0.2238 (0.2552)	-0.0156 (0.1273)	
pct_black:regionNorth City	0.1148 (0.0893)	-0.1285 (0.1369)	-0.2394 (0.1728)	-0.2256 (0.1416)	
pct_black:regionNorth County	-0.0067 (0.0954)	-0.0472 (0.1415)	0.0434 (0.1520)	-0.0936 (0.1008)	
regionFirst Suburb:mean_fico_score		-0.1252 (0.3868)	-0.2574 (0.4020)		
regionNorth City:mean_fico_score		0.0557 (0.1033)	0.0044 (0.1323)		
regionNorth County:mean_fico_score		0.0737 (0.1641)	0.1061 (0.1746)		
Observations	62	62	62	62	62
R <sup>2</sup>	0.8454	0.8863	0.9031	0.9098	0.9003
Adjusted R <sup>2</sup>	0.8114	0.8459	0.8445	0.8590	0.8758
Residual Std. Error	3.9758 (df = 50)	3.5938 (df = 45)	3.6105 (df = 38)	3.4386 (df = 39)	3.2261 (df = 49)
F Statistic	24.8639*** (df = 11; 50)	21.9330*** (df = 16; 45)	15.4031*** (df = 23; 38)	17.8855*** (df = 22; 39)	36.8618*** (df = 12; 49)

Note:

\*p<0.1; \*\*p<0.05; \*\*\*p<0.01

## Conclusions and Discussion

Vacancy has escalated into a crisis in St. Louis, with the third-highest share of unoccupied homes in the country. Much of the home vacancy in the area follows racial lines. Majority-white ZIP codes remain nearly untouched by home vacancy, while the heavily Black ZIP codes in north St. Louis see up to 40% of their housing stock unoccupied. The results from this paper indicate that the differences in home loan terms before and during the Great Recession played a major role in this disparity. Borrowers in Black areas of St. Louis City and St. Louis County faced a fundamentally unfair playing field when securing a home loan. A higher FICO score meant a borrower was less likely to secure a risky subprime loan. However, it was harder for borrowers in St. Louis' majority-Black areas—namely North City, the First Suburbs, and the rest of North County—to use a higher credit score to achieve more favorable loan terms. As a result, these Black borrowers received risky subprime loans far more often than similarly creditworthy borrowers in southern St. Louis regions.

This pattern of results is consistent with Hubbard et al.'s (2011) findings that minorities faced relaxed lending standards from 1996 to 2008 that could not have been justified by risk. This may have allowed people who otherwise would not have received mortgages to finally secure a home loan. However, these loans were often subprime and led to default. More problematic was that subprime loans were not just for low-credit borrowers in the Black North City and North County neighborhoods, but also for the highly creditworthy borrowers there.

The prominence of subprime loans—and especially risky balloon loans—heightened St. Louis' Black regions' vulnerability to the housing crash. With harder loan terms to meet, borrowers in North City and North County fell into payment delinquency and foreclosure more often than those in southern St. Louis regions. This “subprime effect” did not discriminate by credit score. Because even borrowers with high credit scores received subprime loans in North City and North County, they too saw higher rates of payment delinquency and foreclosure than their neighbors to the south. Borrower payment delinquency in turn predicted home vacancy, even controlling for race, region, and a battery of other demographic factors.

Home vacancy is only a part of St. Louis' bigger vacancy problem, but it makes up a large share of it. The difference in how lenders treated credit scores for borrowers of different races led to loans that were harder to keep up with and contributed to the vacancy crisis that has taken hold in North St. Louis City and is spreading toward the First Suburbs. This will likely have consequences that will ripple through the city's neighborhoods. The areas that saw the most subprime lending will also see more crime, illness, and population decline.

The problem of subprime lending and its consequences are difficult to address, but the U.S. government has taken some steps in that direction. The Consumer Financial Protection Bureau, established in 2011, has helped win \$15 billion in consumer relief and nearly \$2 billion in civil penalties in its first decade of existence (Brandus, 2021). Local leaders have taken action to combat vacancy, as well. A group called the St. Louis Vacancy Collaborative that has advised the mayor focuses on repurposing vacant lots and holding their owners accountable (General Info, 2022). This paper suggests that while these efforts may reduce vacancy, it only treats the symptom of a social ill that takes hold when borrowers sign on the dotted line.

For instance, the median borrower in a Black region of St. Louis during the subprime boom period had a 22.6% chance of receiving a subprime loan, a 2.18% chance of a balloon loan, and a 17.48% chance of an ARM. This median borrower, with all the median demographic measures of North St. Louis, sees this translate into a 1.004% chance of their home being foreclosed on, a 0.19% chance of 60-day delinquency, and a 3.55% of 90-day delinquency. This results in an expected home vacancy of 10.85%.

If all regional effects are eliminated, that same borrower would have a 2.41% chance of receiving a balloon loan and a 2.12% chance of an ARM. This reduces the chance of foreclosure to just 0.35%, 60-day delinquency to 0.093%, and 3.05% chance of 90-day delinquency. This eventually leads to an expected home vacancy of 9.11%—slightly lower than without the regional effects.

This study was limited by several factors, foremost of which stems from the CoreLogic data sets. First, the CoreLogic database collects data from many lenders, but the data collection method is unclear. While this data set is often treated as the gold standard of home loan data in the US, it likely does not contain a fully representative sample. Additionally, the CoreLogic database includes information on home loan terms but little on the demographics of the borrowers. Thus, these models identified FICO score as a key factor in lending, but it may have misinterpreted its role in the process due to a lack of information on other key borrower traits like race. This analysis dealt with this issue by including demographic factors for each loan's ZIP code in the models.

The geographic element was another limitation to the analysis. The only geographic information in the CoreLogic data set was the ZIP code in which the property was located. This means that analysis for the final dependent variable, home vacancy, must be limited to large ZCTAs. The analysis managed this issue by including demographic terms to nuance the models, but it lacks the granularity needed to recommend precise action. Furthermore, while the battery of demographic variables has been shown to be associated with home vacancy, it may still be an insufficient set of controlled factors.

Despite these limitations, this work contributes an important examination of the subprime housing boom in the St. Louis area. It represents a departure from previous literature both in its examination of a broader St. Louis area rather than merely the city and by looking at the complex relationship between mortgages and home vacancy. This paper notes the concentration of subprime home loans in North City and North County, which led to higher rates of home vacancy in these majority-Black neighborhoods.

It is crucial to continue researching the details of the St. Louis subprime boom, as there are probably more consequences yet undiscovered in the city with the country's highest murder rate. Research may explore how loan terms differed for each type of subprime loan. It is also worth investigating which specific lenders originated subprime loans in North City and North County neighborhoods and finding their rationale. Finally, future research examining whether these results replicate themselves in other weak-growth American cities merits investigation.

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## Appendix A

### Comparative descriptive statistics of origination and performance data loans

*Note.* All demographic information apart from FICO score, back-end ratio, and region are drawn from the 2000 U.S. Census.

Origination data observations = 315,972

Performance data observations = 171,540

<b>Variable</b>	<b>Mean (Origination)</b>	<b>Mean (Performance)</b>	<b>Std. Dev. (Origination)</b>	<b>Std. Dev. (Performance)</b>
FICO Score at Origination	725.12	730.02	71.48	67.81
Back-end Ratio	34.24	34.26	14.78	13.87
Percent Black in ZCTA	17.43	17.50	24.22	24.27
Unemployment Rate in ZCTA	8.06	8.07	4.42	4.42
Median Age in ZCTA	37.19	37.19	3.86	3.85
Percent Home Ownership in ZCTA	71.77	71.86	15.28	15.16
Average Household Size in ZCTA	2.45	2.46	0.27	0.27
Median Gross Rent in ZCTA	892.78	892.55	184.16	183.34
Median Structure Age in ZCTA	36.95	36.86	14.90	14.84
Median Income in 1999 in ZCTA (in 2019 dollars)	79,909	79,825	31,342	31,098
Percent Married in ZCTA	54.67	54.70	11.04	10.98
Proportion in First Suburb	0.053	0.053		
Proportion in other North County ZCTAs	0.181	0.185		
Proportion in North City	0.043	0.042		
Proportion in South County/South City	0.723	0.720		
Proportion Pre-2003	0.032	0.020		
Proportion from 2003-2007	0.232	0.162		
Proportion Post-2007	0.736	0.818		